

PEARSON EDEXCEL IAL BIOLOGY • YBI11

BIOLOGY



EXAM QUESTION PACK

UNIT 2: CELL STRUCTURE, REPRODUCTION AND DEVELOPMENT

SCORE

/497

PERCENTAGE

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STEMUP

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Q1.

The photograph shows a Venus fly trap (*Dionaea muscipula*), a plant native to North and South Carolina in the United States.



This plant is found in nitrogen and phosphorus poor environments, such as a bog. The plant catches and digests insects and spiders and absorbs compounds containing nitrogen.

(a) Explain why the Venus fly trap needs compounds containing nitrogen.

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(b) The Venus fly trap secretes extracellular enzymes that digest the insects and spiders it catches.

Describe the role of the Golgi apparatus in forming these extracellular enzymes.

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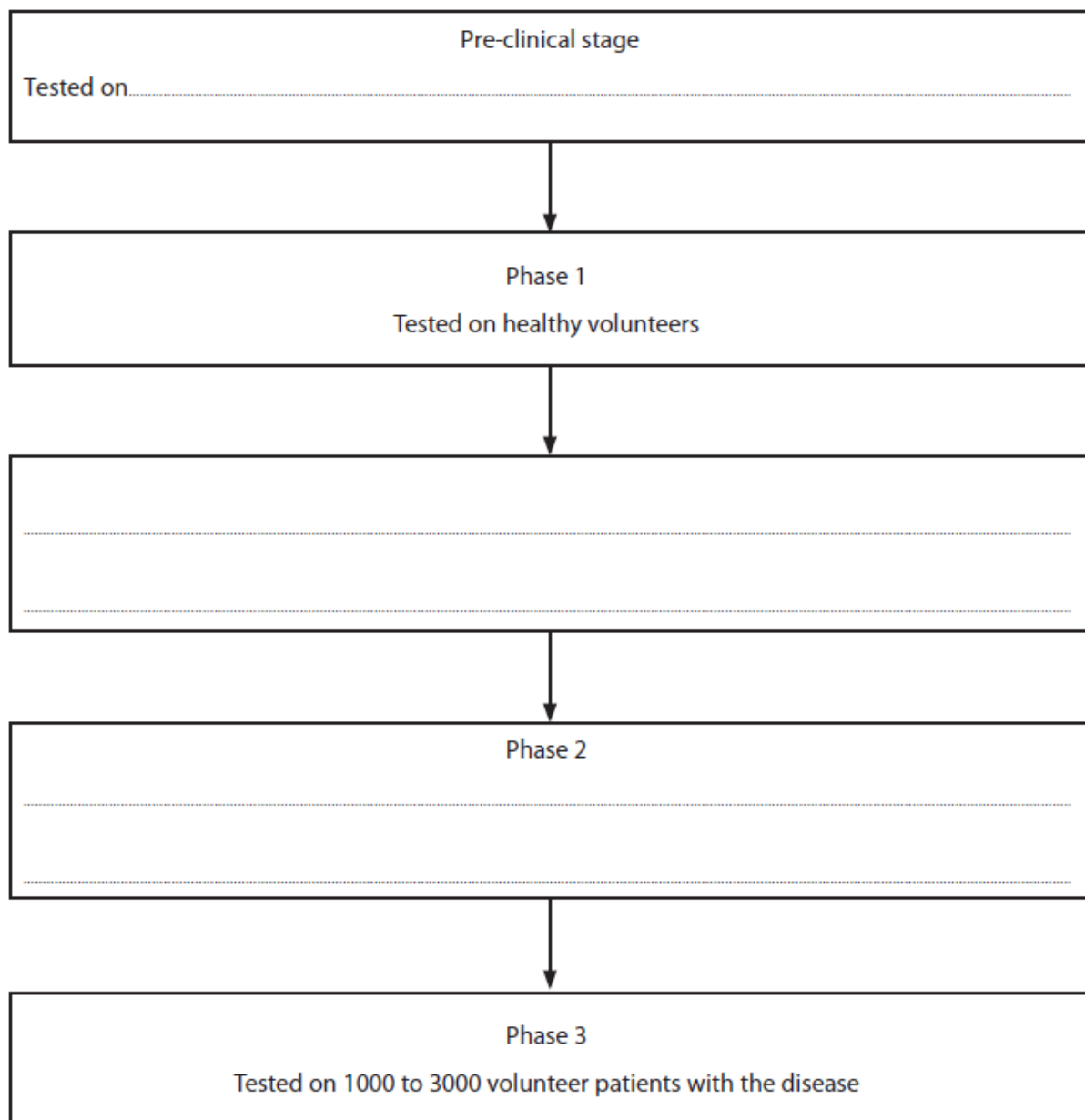
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(c) Extracts from Venus fly trap plants are used in some alternative medicines as a treatment for HIV and some cancers.

Complete the diagram to show how an extract could be tested as part of the initial stages of a drug trial.

(3)



(Total for question = 7 marks)

Q2.

Many female organisms produce egg cells containing cortical granules.

(a) Explain how cortical granules ensure that the egg cell is diploid after fertilisation.

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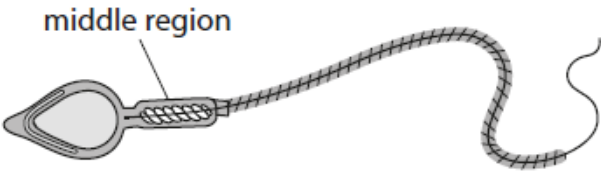
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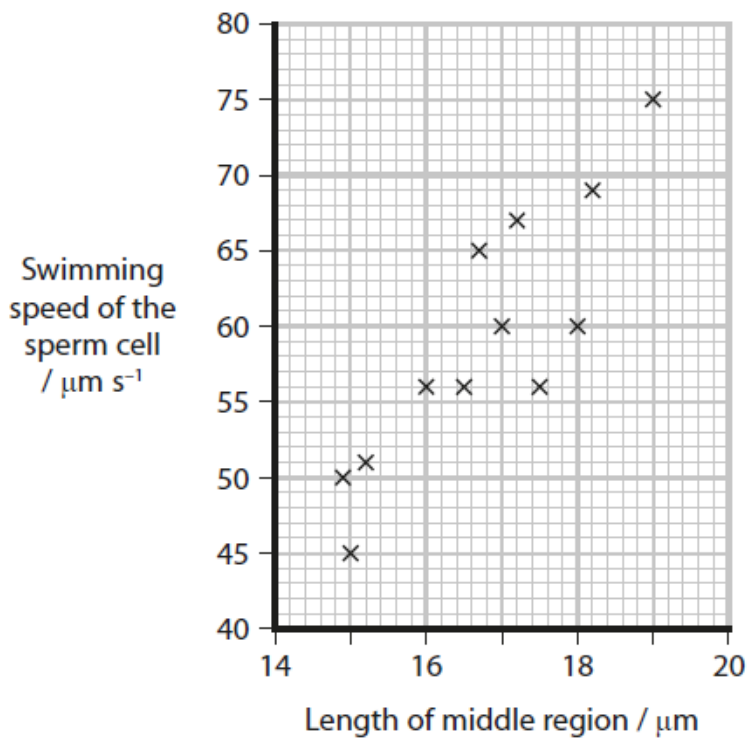
*(b) Organisms have evolved different mating strategies such as:

- Some male animals have sperm cells with longer middle regions, as shown in the diagram.



The females of these species produce multiple egg cells and mate with many males in a short period of time.

The graph shows the effect of the length of the middle region on the swimming speed of the sperm cell.



- Some male animals, such as the zebra longwing butterfly, produce spermatophores that remain inside the reproductive system of the female after mating.

The spermatophore contains sperm cells and nutrients for the female. The spermatophore also releases chemicals that reduce the attractiveness of this female butterfly to other males.

- Some female animals, such as the eastern box turtle, mate with numerous males and then store the sperm for a number of years. This allows fertilised egg cells to be laid even when the female has not mated in that year.

Comment on the effect that these three mating strategies would have on the reproductive success of the males and females, and the genetic diversity of the offspring.

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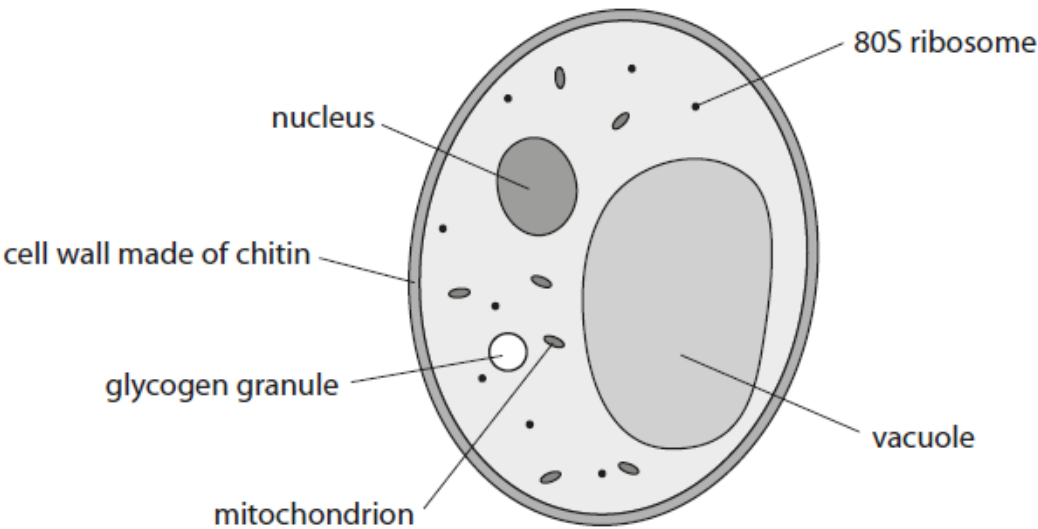
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(Total for question = 10 marks)

Q3.

Some fungi infect plants and affect the expression of the plant genes.

(a) A student drew and labelled a fungal cell.



Compare and contrast the structure of this fungal cell and a plant cell.

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(b) The photograph shows darnel, a species of grass.



© blickwinkel / Alamy Stock Photo

The fungus *Epichloë festucae* lives within darnel for part of its life cycle.

The fungus influenced the expression of certain genes in the plant cells.

- There was reduced expression of some genes involved in DNA synthesis.
- There was reduced expression of some genes involved with the synthesis of phospholipids, starch and sucrose.

(i) Explain the effect of this fungal infection on the growth of the plant.

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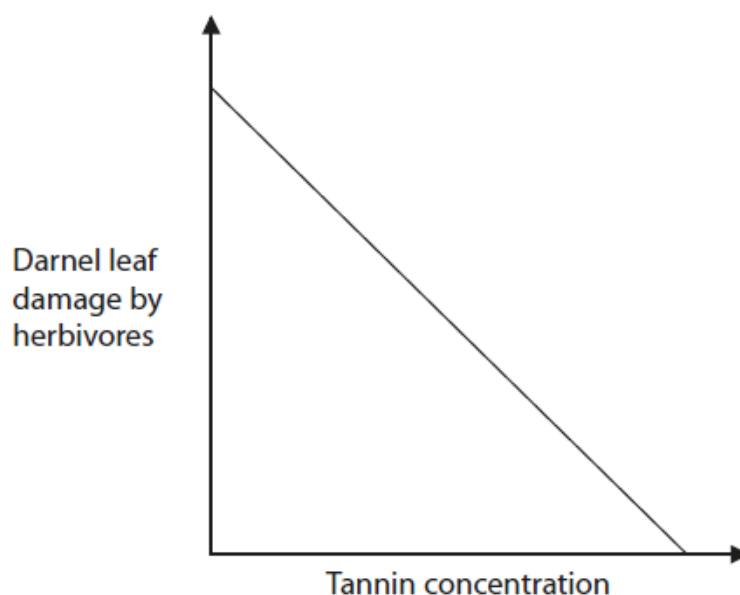
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The fungus absorbs nutrients from the plant.

The expression of certain genes in the plant cells is increased when infected with the fungus.

These genes are involved in the synthesis of tannin and flavonoids.

The graph shows the relationship between tannin concentration and the degree of darnel leaf damage by herbivores (grazing animals).



The table shows the antimicrobial effect of different concentrations of flavonoids on cultures of the bacterium *Pseudomonas aeruginosa*. This bacterium causes disease in plants.

Flavonoid concentration / $\mu\text{g cm}^{-3}$	Diameter of inhibition zone / mm
500	7.0
666	8.0
1000	9.0

The fungus increases the expression of the genes involved in the synthesis of tannin and flavonoids.

Discuss the advantages and disadvantages of this for the fungus and for the infected plants.

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(iii) The bacterium *Pseudomonas aeruginosa* causes lung infections in humans.
Describe how a drug containing flavonoids could be tested in a stage II drug trial.

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(Total for question = 15 marks)

Q4.

Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

The nucleus of a cell contains chromosomes.

The diagram shows three genes present on a pair of chromosomes.



(a) (i) How many of the following statements about this diagram are correct?

- there are three gene loci
- the pair of chromosomes will be separated into different cells following mitosis
- one chromosome was inherited from the mother and one chromosome was inherited from the father

(1)

- ☐ **A** none
- ☐ **B** one
- ☐ **C** two
- ☐ **D** three

(ii) Describe what will happen to these chromosomes when they enter the interphase stage of the cell cycle.

(2)

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(b) Crossing over between pairs of chromosomes increases genetic variation.

(i) Name the stage of meiosis in which crossing over begins.

(1)

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(ii) How many of the following combinations could result from one crossover of the chromosomes shown in the diagram?

- AbE
- ABe
- abE
- abe

(1)

- ☐ **A** one
- ☐ **B** two
- ☐ **C** three
- ☐ **D** four

(iii) Explain why alleles b and e are more likely to be inherited together than alleles A and e.

(2)

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(Total for question = 7 marks)

Q5.

Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

The number and size of Golgi apparatus vary depending on the type of cell.

(a) (i) Draw a labelled diagram of the Golgi apparatus.

(4)

(ii) How many of the following are functions of the Golgi apparatus?

- formation of extracellular enzymes
- modification of proteins
- formation of peptide bonds through condensation reactions

(1)

☐ **A** none

☐ **B** one

☐ **C** two

☐ **D** three

(iii) A cell was supplied with radioactive amino acids. The cell took in these amino acids and

used them in protein synthesis.

Which structure in the cell would become radioactive first?

(1)

- ☐ **A** centrioles
- ☐ **B** Golgi apparatus
- ☐ **C** lysosomes
- ☐ **D** ribosomes

(b) In a mammalian cell, there was one Golgi apparatus with a diameter of 1.1 μm .

In a maize cell, there were 600 Golgi apparatus. The largest diameter of Golgi apparatus in the maize cell was 0.5 μm .

(i) Calculate the percentage difference in these diameters.

(1)

Answer %

(ii) The number and size of the Golgi apparatus in the maize cell increases during one stage of the cell cycle.

In which stage of the cell cycle would the number and size of the Golgi apparatus increase?

(1)

- ☐ **A** anaphase
- ☐ **B** interphase
- ☐ **C** prophase
- ☐ **D** telophase

(iii) Suggest why the number and size of the Golgi apparatus change during the cell cycle.

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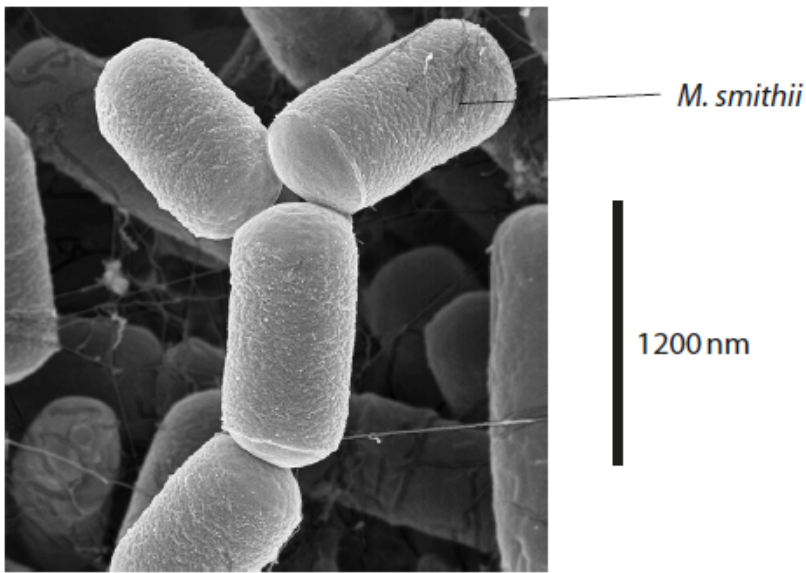
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(Total for question = 12 marks)

Q6.

Methanobrevibacter smithii (*M. smithii*) is a single-celled microorganism found in the human intestine.

The photograph shows *M. smithii*.



(© DENNIS KUNKEL MICROSCOPY / SCIENCE PHOTO LIBRARY)

(a) (i) Calculate the magnification of this photograph.

Give your answer in standard form to two significant figures.

(2)

Answer

(ii) Explain which type of microscope was used to take this photograph.

(2)

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(b) Scientists classified this microorganism as a species in the domain Archaea.

(i) Describe the information the scientists would have used to classify *M. smithii* into the Archaea domain.

(2)

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(ii) Scientists have identified a similar microorganism in the human mouth.

This microorganism is called *Methanobrevibacter oralis* (*M. oralis*).

Explain how the scientists could confirm that *M. smithii* and *M. oralis* are different species of Archaea.

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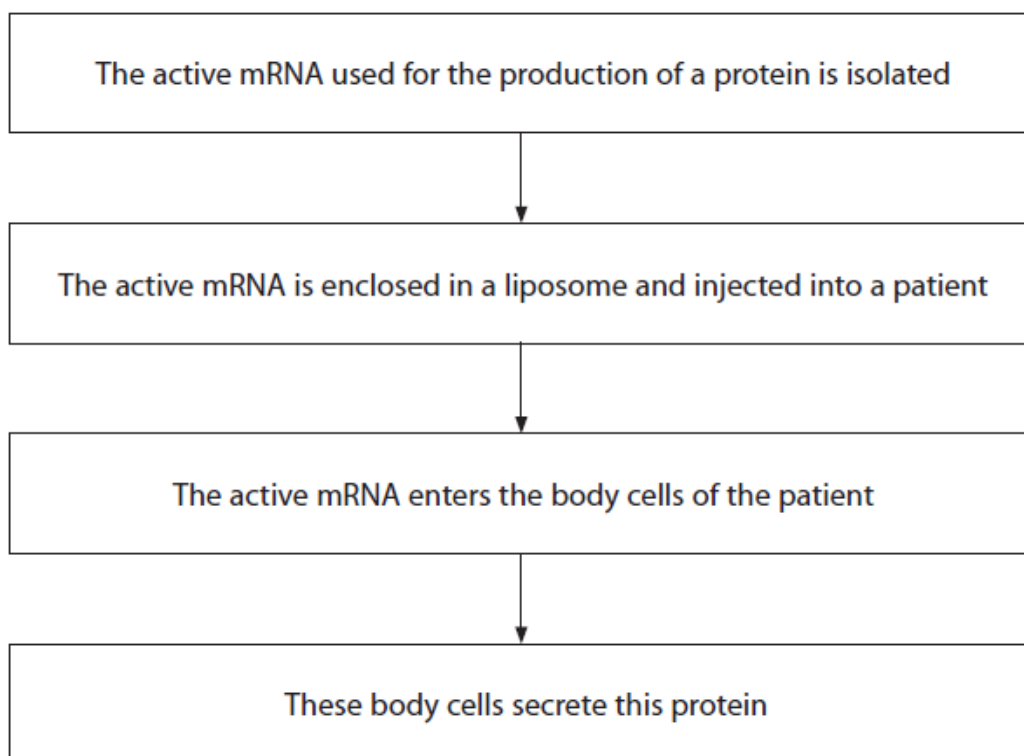
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(Total for question = 9 marks)

Q7.

A new vaccine has been developed that contains active mRNA.

The flow diagram shows how this vaccine causes body cells to produce a new protein.



(a) The diameter of one spherical liposome was 75 nm.

Calculate the volume of this liposome using the formula:

$$V = \frac{4}{3}\pi r^3$$

Give your answer in standard form.

(2)

Answer nm³

(b) Active mRNA is formed after post-transcriptional modification of pre-mRNA.

The structure of pre-mRNA produced from transcription is different from the structure of active mRNA.

Compare and contrast the structures of pre-mRNA and active mRNA.

(4)

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(Total for question = 6 marks)

Q8.

The scientist Carl Woese proposed the three-domain system of classification.

The photograph shows *Haemanthus albiflos*, a flowering plant native to South Africa.



(Source: © COULANGES/Shutterstock)

(a) (i) Which of the following is the domain for this plant?

(1)

- ☐ **A** Archaea
- ☐ **B** Bacteria
- ☐ **C** Eukarya
- ☐ **D** Prokaryota

(ii) Describe the evidence that Carl Woese used to support his system of classification.

(2)

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(b) A pollen grain can germinate on the stigma of a flower.

After germination, a pollen tube grows through the style.

Explain the function of a pollen tube in the fertilisation of flowering plants.

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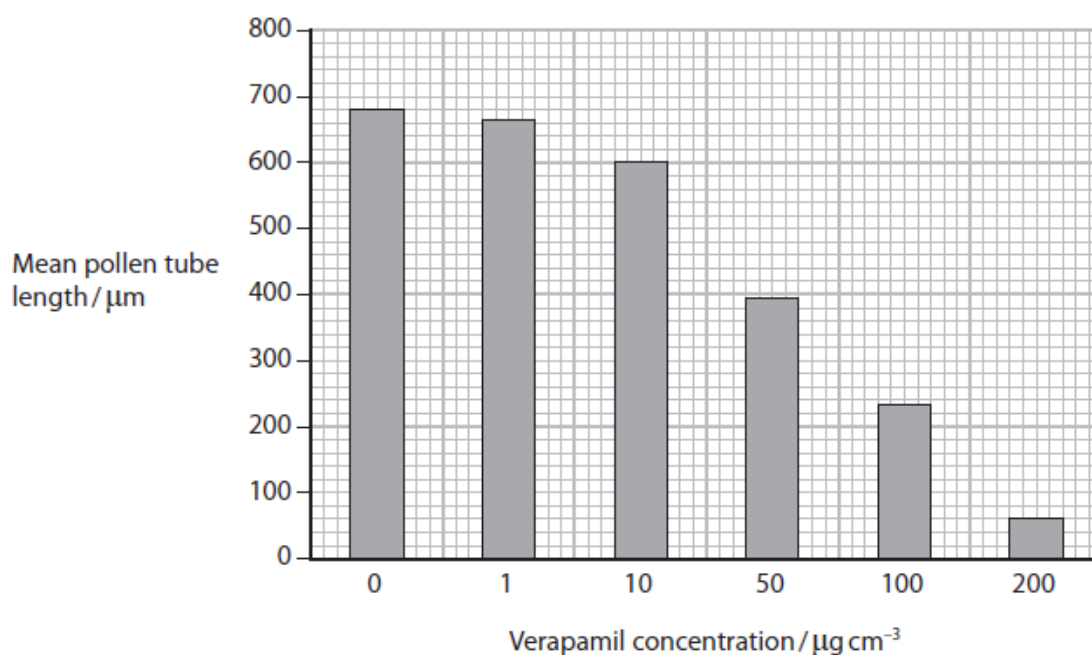
(c) Verapamil is a substance that inhibits the uptake of calcium ions by the pollen tube.

An investigation was carried out to study the effect of Verapamil on the growth of pollen tubes.

Each pollen sample was exposed to a different concentration of Verapamil solution.

The lengths of the pollen tubes in each sample were measured after one hour.

The graph shows the mean length of the pollen tubes after one hour in each concentration of Verapamil.



(i) Determine the effect of Verapamil concentration on the growth of pollen tubes.

(2)

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(ii) Explain why Verapamil can reduce the strength of cell walls.

(3)

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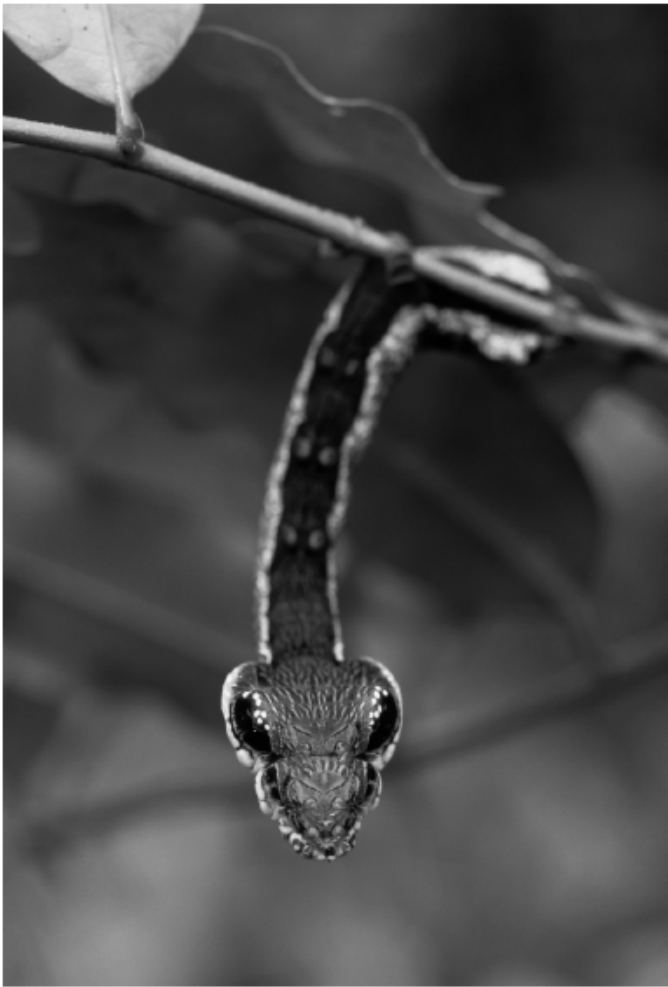
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(Total for question = 11 marks)

Q9.

The photograph shows the caterpillar of a moth from Costa Rica.

The caterpillar looks like a pit viper snake. It will try to strike potential predators.



(Source: © Avalon/Photoshot License / Alamy Stock Photo)

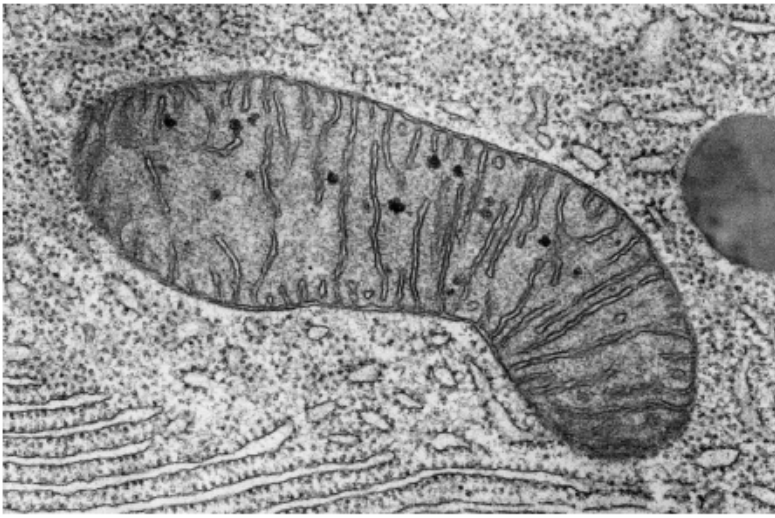
(a) This caterpillar is adapted to its niche.

Complete the table to show the type of adaptations shown by this caterpillar.

(2)

Feature	Type of adaptation
looks like a pit viper snake	
tries to strike potential predators	

(b) The photograph shows an organelle that can be found in caterpillar cells, as seen using a microscope.



(Source: © Science History Images / Alamy Stock Photo)

Magnification $\times 72\,500$

(i) State the type of microscope used to view this organelle.

(1)

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(ii) Describe the function of this organelle.

(3)

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(c) Rough endoplasmic reticulum is another organelle found in caterpillar cells.

Draw a labelled diagram of rough endoplasmic reticulum.

(3)

(Total for question = 9 marks)

Q10.

All organisms contain one or more cells.

(a) (i) In which of the following is a cell membrane present?

(1)

- ☐ **A** animal cells only
- ☐ **B** animal and plant cells only
- ☐ **C** plant and prokaryotic cells only
- ☐ **D** animal, plant and prokaryotic cells

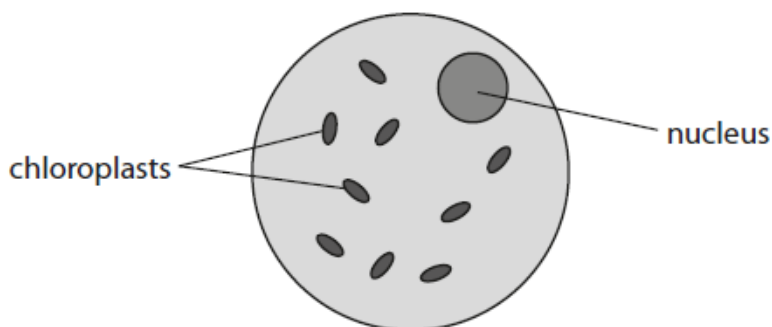
(ii) In which of the following is a cell wall present?

(1)

- ☐ **A** plant cells only
- ☐ **B** animal and plant cells only
- ☐ **C** plant and prokaryotic cells only
- ☐ **D** animal, plant and prokaryotic cells

(b) Sailor's eyeball (*Valonia ventricosa*) is a single-celled, spherical organism.

The diagram shows one of these cells.



(i) The diameter of this cell is 25 μm .

Calculate the magnification of the diagram.

(2)

Answer

(ii) This cell contains chloroplasts.

State the function of these chloroplasts.

(1)

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(iii) This cell is not a prokaryotic cell as it contains chloroplasts.

Give **one** other reason why this organism is not a prokaryotic cell.

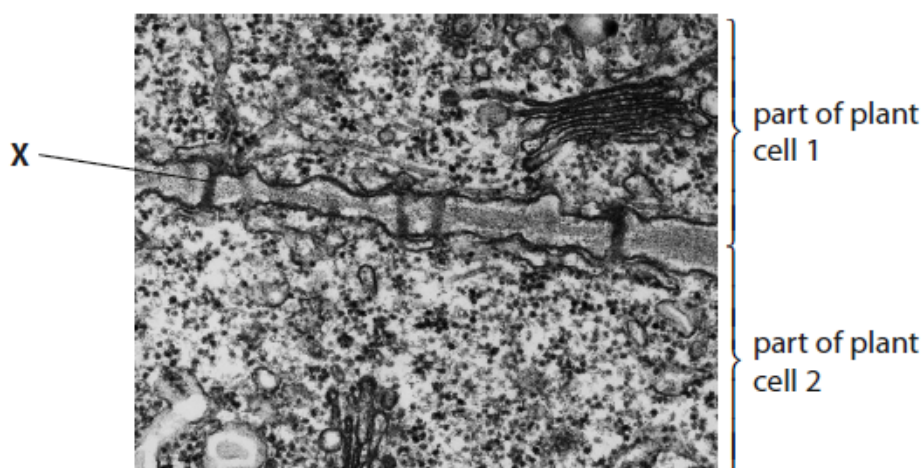
(1)

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(c) The photograph shows part of two adjoining plant cells, as seen using an electron microscope.



(Source: © biophoto associates/Getty Images)

(i) Name the part labelled **X**.

(1)

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(ii) Explain the function of the part labelled **X**.

(2)

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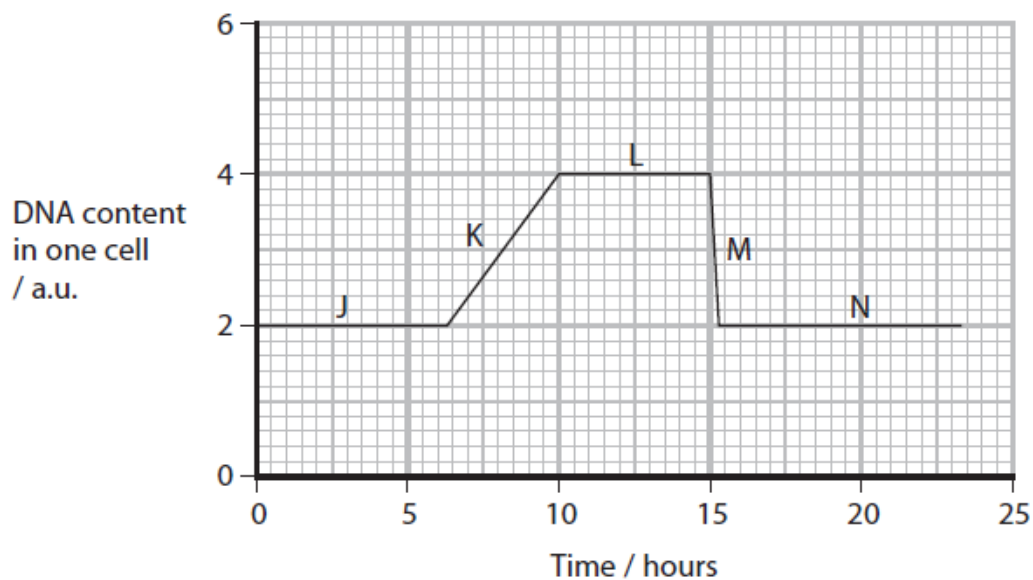
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(Total for question = 9 marks)

Q11.

Answer the questions with a cross in the boxes you think are correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The graph shows the changes in the DNA content of one cell during one cell cycle.



(a) (i) In which part of the graph is the DNA being replicated?

(1)

- ☒ A J
- ☒ B K
- ☐ C L
- ☐ D M

(ii) In which part of the graph would the condensation of chromosomes be completed?

(1)

- ☒ **A** J
- ☒ **B** L
- ☒ **C** M
- ☒ **D** N

(b) Centrioles are involved in spindle formation.

(i) Name the stage of mitosis when spindle fibres begin to form.

(1)

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(ii) Explain the role of the spindle in mitosis.

(2)

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(iii) Draw a plant cell undergoing cell division, after mitosis has just finished.

(2)

(c) The photograph shows a section through a root tip, as seen using a microscope.



(Source: © agefotostock / Alamy Stock Photo)

Describe how to determine the mitotic index of this tissue.

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(Total for question = 9 marks)

Q12.

Stomach ulcers are sores that develop in the lining of the stomach.

The mucus produced by the stomach prevents bacteria from reaching the lining of the stomach.

Stomach ulcers can be caused by infection with the bacterium *Helicobacter pylori*.

These bacteria reproduce in the stomach as it provides all the conditions required for the growth of bacteria.

(a) Explain the conditions needed for the growth of bacteria.

(4)

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(b) The plant *Cibotium barometz* is native to several countries in East Asia.

The photograph shows hairs on the surface of this plant.



(Source: © Mauro Rodrigues/123RF)

Extracts from the hairs on this plant have antimicrobial properties.

An investigation compared the use of this extract and the drug omeprazole to treat stomach ulcers in rats.

The mass of mucus and the area of ulcer were measured in five groups of rats.

The table shows the treatments and the results of this investigation.

Group	Treatment / mg kg^{-1}	Mean mass of mucus / g	Mean area of ulcer / mm^2
Control rats with no ulcer	0.00	2.28	0.00
Control rats with ulcer	0.00	0.75	802.71
Rats with ulcer treated with omeprazole	20.00	1.92	95.71
Rats with ulcer treated with extract	125.00	1.87	202.80
Rats with ulcer treated with extract	500.00	2.17	172.80

(Source: adapted from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5244617/>)

(i) Calculate the percentage decrease in the mean areas of ulcer of the rats treated with omeprazole compared with the control rats with ulcer.

(2)

Answer %

*(ii) Explain the results of this investigation.

Use all the information in Question 6 to support your answer.

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(Total for question = 12 marks)

Q13.

The five stages of cancer are used to describe the size and spread of a cancer in a human body.

(a) The mitotic index of a tissue can be used to determine the stage of cancer.

A higher mitotic index is usually linked to a later stage of cancer.

The mitotic index is calculated using the formula

$$\text{Mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}} \times 100$$

Tests were performed on three patients, P, Q and R, who had cancer.

The table shows the number of cells that were counted in each stage of the cell cycle per mm² of tissue, taken from the same organ in each patient.

Patient	Interphase	Prophase	Metaphase	Anaphase	Telophase
P	16	1	3	0	0
Q	14	2	1	1	2
R	11	2	2	3	2

(i) State what is meant by the term **tissue**.

(1)

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(ii) Using the data in the table, determine the stages of cancer in patients P and R.

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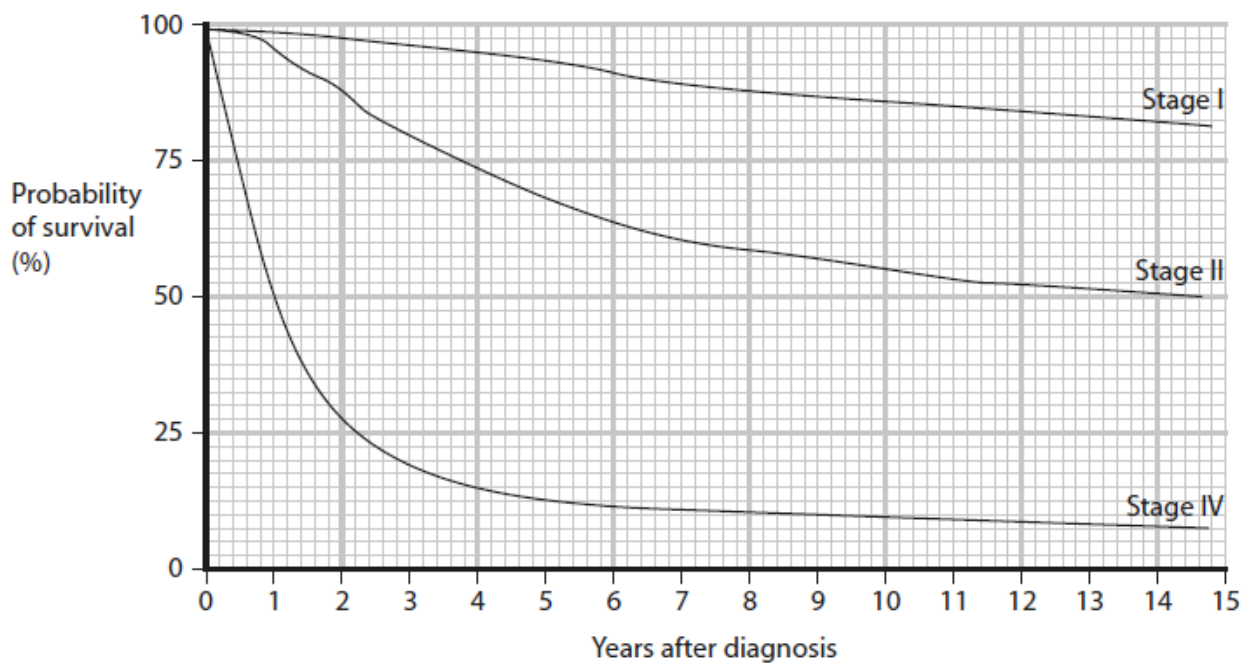
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(b) The graph shows the probability of survival for different stages of a cancer, after diagnosis.



(Source: http://www.mmmp.org/MMMP/import.mmmp?page=tnm_staging.mmmp)

Compare and contrast the probabilities of survival for the different stages of this cancer, as shown by the graph.

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(c) Anticancer drugs have to undergo double-blind trials before they are used to treat patients. Describe how a placebo is used in a double-blind trial.

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(Total for question = 9 marks)

Q14.

The photograph shows a Baird's tapir.



Source: <https://www.biolib.cz/IMG/GAL/171566.jpg>

(a) Baird's tapir is endemic to countries in Central America.

State what is meant by the term **endemic**.

(1)

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(b) Baird's tapir is classified as endangered.

In 2006, it was estimated that there were 5500 Baird's tapirs. This number had fallen to 3000 in 2016.

(i) Calculate the percentage decrease in the number of Baird's tapirs from 2006 to 2016.

(2)

Answer %

(ii) Explain how human activity, other than hunting, could have caused this decrease in the

number of Baird's tapirs.

(3)

(c) Preservation of sperm collected from Baird's tapir may help captive breeding programmes.

Scientists investigated the effect of freezing on sperm from Baird's tapir.

The sperm were frozen and then thawed.

The results of this investigation are shown in the table.

Sperm	Percentage of sperm capable of moving (%)	Ability of sperm to swim in a straight line / a.u.	Percentage of sperm with an undamaged acrosome (%)
Freshly collected	63	3.5	80
Frozen and then thawed	38	2.5	48

(i) Describe how each of these effects of freezing could be determined.

(3)

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(ii) Explain how freezing sperm could affect the success of captive breeding programmes.

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(Total for question = 13 marks)

Q15.

All living organisms are made of cells.

Eukaryotic cells and prokaryotic cells have some features in common and some differences.

(a) (i) Which cells have a cell wall?

(1)

- ☐ **A** plant cells only
- ☐ **B** animal cells and prokaryotic cells
- ☐ **C** plant cells and prokaryotic cells
- ☐ **D** animal cells, plant cells and prokaryotic cells

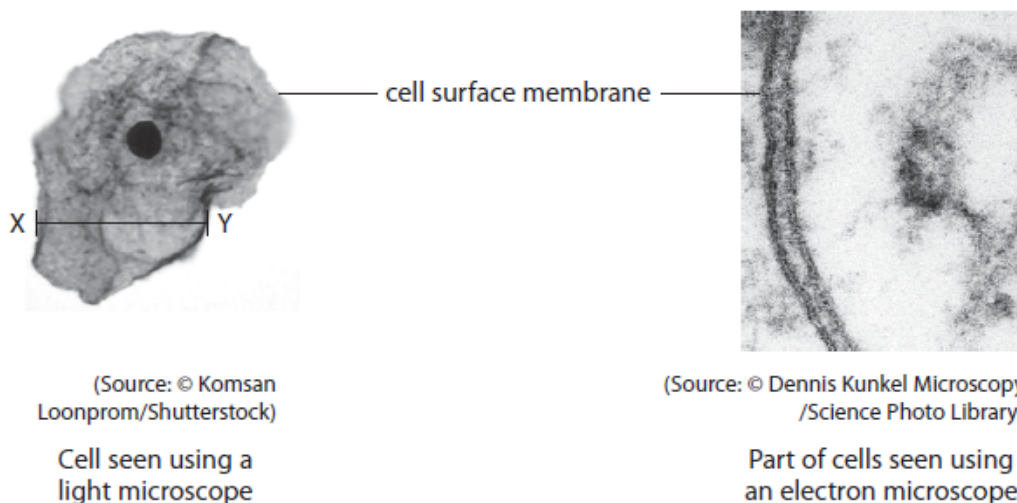
(ii) Eukaryotic cells contain a nucleus.

Draw a labelled diagram of a nucleus, as seen using an electron microscope.

(4)

(b) The photographs show a cell as seen using a light microscope and part of two cells using an electron microscope.

The bilayer structure of the cell surface membrane can be seen only with an electron microscope.



(i) Explain why the bilayer structure of the cell surface membrane could not be seen using a light microscope.

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(ii) The light microscope magnified the cell 200 times.

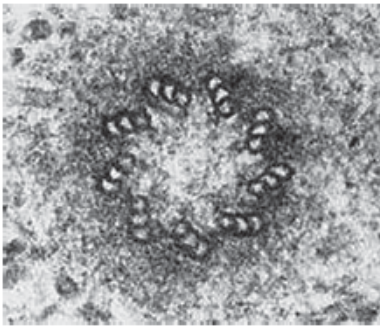
Calculate the actual width of this cell by measuring the line XY.

Give your answer in μm .

(3)

Answer μm

(iii) The photograph shows an organelle that can be found in a eukaryotic cell, as seen using an electron microscope.



Describe the function of this organelle.

(2)

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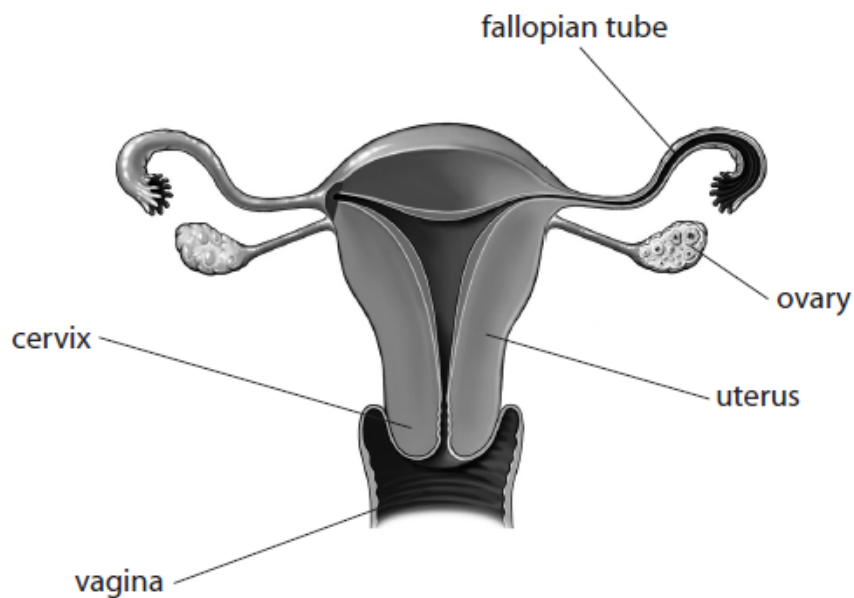
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(Total for question = 12 marks)

Q16.

Answer the questions with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The diagram shows an organ system of a human female.



(Source: © Nucleus Medical Media Inc / Alamy Stock Photo)

(a) State what is meant by the term **organ system**.

(1)

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(b) Gametes are produced in one of the tissues in the ovary.

(i) State what is meant by the term **tissue**.

(1)

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(ii) Gametes are specialised for their functions.

Complete the table to show the correct statement for each structure found in gametes.

(4)

Structure	Propels male gamete towards female gamete	Modified by the action of cortical granules	Produces ATP by respiration	Contains linear DNA
flagellum	☐ A	☐ B	☐ C	☐ D
mitochondria	☐ A	☐ B	☐ C	☐ D
nucleus	☐ A	☐ B	☐ C	☐ D
zona pellucida	☐ A	☐ B	☐ C	☐ D

(Total for question = 6 marks)

Q17.

Fertilisation in mammals, such as the African northern white rhino, results in the fusion of gamete nuclei.

The photograph shows the last two remaining northern white rhinos.

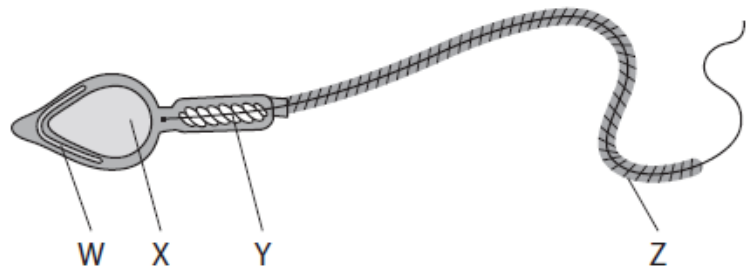
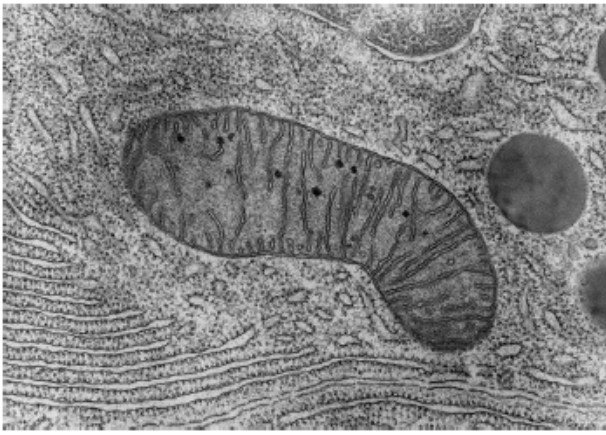
Both of these rhinos are female.



(Source: © Xinhua/Alamy Stock Photo)

Sperm and tissue samples were taken from the last few male northern white rhinos before they died. The sperm samples were frozen.

(a) The photograph shows an organelle taken from a sperm cell, as seen using an electron microscope. The diagram shows a sperm cell.



(Source: © Science History Images/Alamy Stock Photo)

In which part of this sperm cell would this organelle be found?

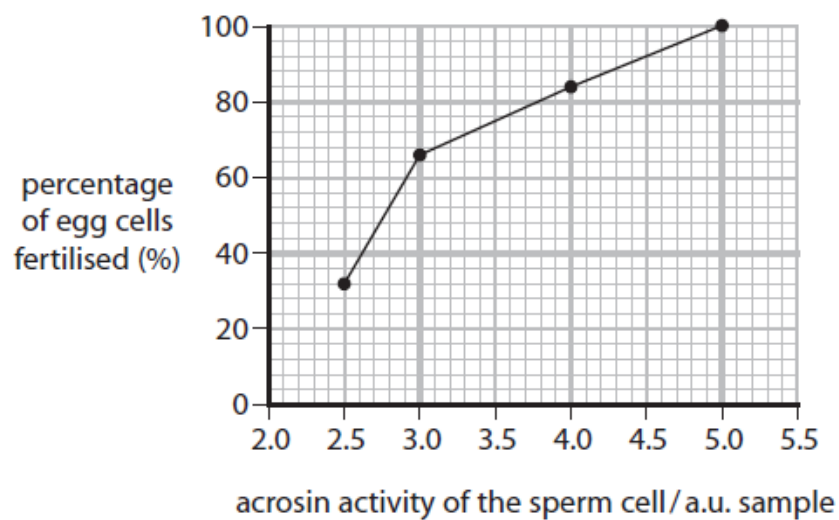
(1)

- ☐ A W
- ☐ B X
- ☐ C Y
- ☐ D Z

(b) Sperm cells contain a digestive enzyme called acrosin.

The effect of acrosin activity of samples of sperm cells on the percentage of egg cells fertilised was investigated.

The graph shows the results of this investigation.



(i) Describe the role of **one** organelle involved in the production of this enzyme.

Organelle

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Role

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(ii) The investigation used 2500 egg cells for each sample of sperm cells.

Calculate the number of egg cells that would have been fertilised by sperm cells with 2.5 a.u. acrosin activity.

(1)

Answer

(iii) Explain why a higher activity of the digestive enzyme acrosin resulted in a higher percentage of egg cells being fertilised.

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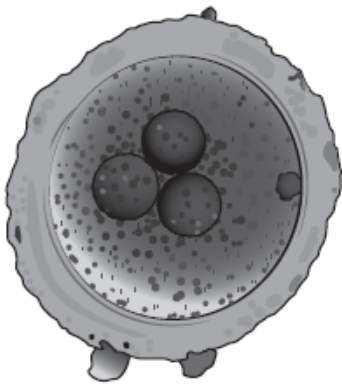
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(c) In vitro fertilisation (IVF) has been used to fertilise northern white rhino egg cells using the frozen sperm samples.

The zona pellucida of some egg cells were damaged when they were removed from the ovaries of the females.

The drawing shows a fertilised egg cell with three nuclei.



magnification $\times 200$

(i) State how to calculate the actual size of this egg cell.

(1)

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(ii) Suggest why this fertilised egg cell has three nuclei.

(3)

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(Total for question = 12 marks)

Q18.

Egg cells are produced by many organisms.

The development of fish embryos can be studied using fertilised egg cells.
The photograph shows part of a beluga fish from the Caspian Sea.



(Source: © Design Pics / Alamy Stock Photo)

(a) Explain how an egg cell is specialised for its function.

(2)

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(b) A student studied beluga fish cells undergoing mitosis and meiosis.

(i) Compare and contrast metaphase in mitosis and meiosis.

(3)

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(ii) Some of the cells undergoing mitosis were from a beluga morula whereas some of the cells were from a beluga blastocyst.

Explain how the cells of the beluga morula change as they develop into the cells of the blastocyst.

(4)

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(c) Chickens produce eggs.
The effect of the age of a chicken on the mass of the eggs it laid was investigated.

A statistical test can be used to see if there is a significant correlation between the age of a chicken and the mass of her eggs.

The value generated by this statistical test will always be between -1.0 to $+1.0$.

The table shows the mass of eggs collected from chickens of different ages.

Age / weeks	Rank of age	Mass of egg / g	Rank of mass of egg	D	D^2
36	1	2.27	8	-7	49
39	2	1.91			
42	3	2.18	5.5	-2.5	6.25
45	4	2.28	9	-5	25
48	5	2.12	4	1	1
51	6	2.19	7	-1	1
54	7	2.18	5.5	1.5	2.25
57	8	2.09	3	5	25
60	9	2.03	2		

- (i) Calculate the value for $\sum D^2$.
Use the table to help you.

(2)

$$\sum D^2 = \dots\dots\dots$$

- (ii) Calculate the correlation coefficient, r_s value, for this data using the formula:

(2)

$$r_s = 1 - \frac{6(\sum D^2)}{n(n^2 - 1)}$$

Answer

- (iii) The null hypothesis is that there was no significant correlation between the age of the chicken and the mass of the eggs laid.

Another scientist replicated this study and gained a correlation coefficient value of 0.38.
The table shows the critical values at the 95% probability level.

Number of pairs of data	Critical values at the 0.05 % probability level
8	0.738
9	0.683
10	0.648

Explain whether the null hypothesis should be accepted or rejected.

(2)

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(Total for question = 15 marks)

Q19.

The photograph shows a species of harvest mouse native to countries in Asia.



(Source: © Mark Bridger/Shutterstock)

(a) The body of this species of harvest mouse is 55 mm to 75 mm long and its tail is 50 mm to 75 mm long.

The body of the Indian flat-haired mouse is 10 cm to 12 cm long and its tail is 7 cm to 8 cm long.

Calculate the percentage difference in **minimum** total length of the Indian flat-haired mouse compared with the **minimum** total length of the harvest mouse.

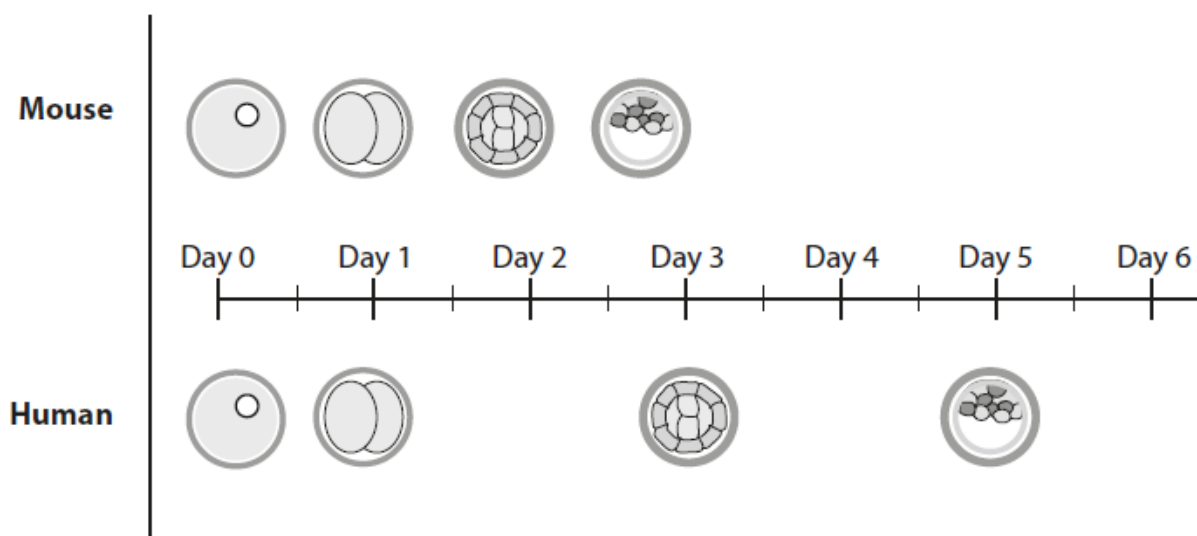
Give your answer to **two** significant figures.

(2)

Answer %

(b) The diagram shows the timeline for the structures formed after fertilisation in a mouse and in a human.

A fertilised egg cell is called a zygote.



(i) As mouse egg cells develop they accumulate small spherical lipid droplets.

These lipid droplets have a mean radius of $88 \mu\text{m}$.

The volume of a sphere (V) is calculated using the formula

$$V = \frac{4}{3} \pi r^3$$

Which of the following gives the mean volume of a lipid droplet in mm^3 ?

(1)

- ☒ A 2.85×10^{-6}
- ☒ B 2.85×10^{-3}
- ☒ C 2.85×10^3
- ☒ D 2.85×10^6

(ii) Draw a circle around the part of the diagram that is a mouse morula. Label the circle 'morula'.

(1)

(iii) Describe the events that occur after a sperm cell enters an egg cell, until a zygote is formed.

(3)

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(c) Analysis of some mouse egg cells showed that the lipid droplets were located within 10 nm of mitochondria.

Suggest why mitochondria were located within 10 nm of the lipid droplets.

(3)

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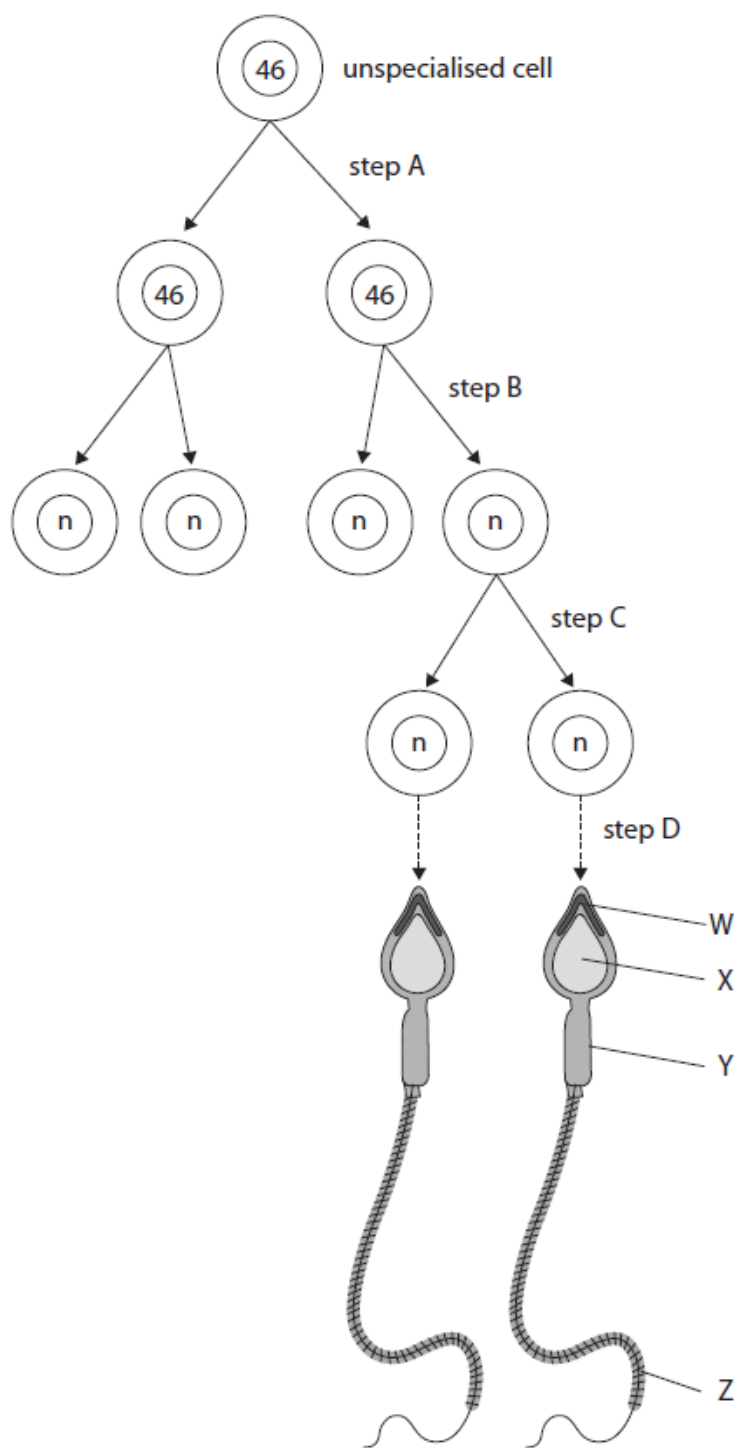
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(Total for question = 10 marks)

Q20.

Answer the questions with a cross in the boxes you think are correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The diagram shows some of the steps involved in the production of human sperm cells from an unspecialised cell. This process involves both mitosis and meiosis.



(a) (i) The unspecialised cell is diploid.

State the types of division occurring at step A and step B.

(2)

step A

step B

(ii) Which part of the sperm cell contains enzymes that are released to break down the zona pellucida?

(1)

☒ A W

☐ **B** X

☐ **C** Y

☐ **D** Z

(b) A sperm cell is a specialised cell.

Explain what happens at step D for the cell to become a specialised sperm cell.

(5)

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(c) The nucleus of a sperm cell fuses with the nucleus of an egg cell to form a zygote. The zygote develops into a blastocyst.

(i) Draw a diagram to show the arrangement of the cells of a blastocyst.

(2)

(ii) The blastocyst contains some pluripotent stem cells.

Which of the following describes these pluripotent stem cells?

(1)

☐ **A** adult stem cells that can give rise to most types of cell in the body, including totipotent

cells

- ☐ **B** adult stem cells that can give rise to most types of cell in the body, excluding totipotent cells
- ☐ **C** embryonic stem cells that can give rise to most types of cell in the body, including totipotent cells
- ☐ **D** embryonic stem cells that can give rise to most types of cell in the body, excluding totipotent cells

(d) The photograph shows a Mexican salamander.



(Source: © Imagebroker/Alamy Stock Photo)

Salamanders can regenerate damaged limbs and organs throughout their lives.
An ethics committee has approved the use of stem cells taken from salamanders.
Suggest why the use of stem cells taken from salamander embryos was approved.

(2)

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(Total for question = 13 marks)

Q21.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

Listeria monocytogenes is a bacterium that contaminates food and causes the disease listeriosis.

The photograph shows a colony of these bacteria, as seen using an electron microscope.



(Source: © BSIP SA / Alamy Stock Photo)

(a) The bacterium labelled X on the photograph is $0.5\text{ }\mu\text{m}$ in length.

(i) Calculate the magnification of this image.

(1)

Answer

(ii) State why a light microscope cannot be used to view these bacteria.

(1)

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(b) The photograph shows a bottle of oil extracted from the plant oregano. This plant is native to Mediterranean and western Asian countries.



(Source: © Frank Hecker / Alamy Stock Photo)

Oregano oil contains antimicrobial substances.

This oil can be used in the production of plastic used to package food.

Explain why this packaging may be chosen over traditional oil-based plastic packaging.

(2)

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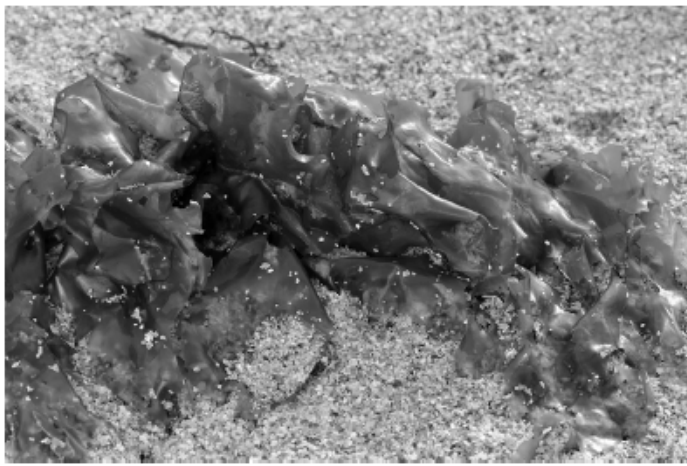
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(c) The photograph shows green algae called sea lettuce (*Ulva lactuca*).



(Source: © Arterra Picture Library / Alamy Stock Photo)

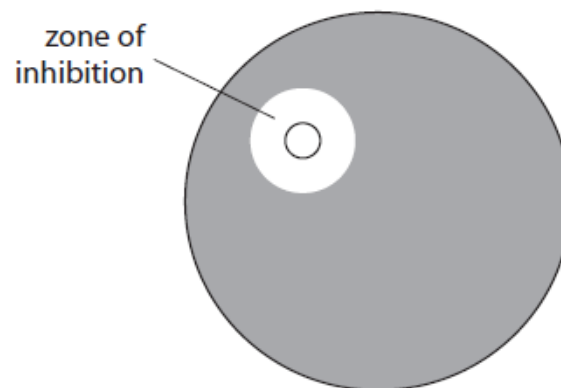
Sea lettuce contains chemicals called fucoxanthins that have antimicrobial properties.

The antimicrobial properties of these chemicals were investigated.

Discs containing fucoxanthin chemical were placed onto four agar plates each seeded with a different type of bacteria.

These plates were then incubated for 24 hours at 25 °C and the zone of inhibition measured.

The diagram shows the zone of inhibition.



The table shows the results of this investigation.

Type of bacteria	Mean diameter of the zone of inhibition / mm	Range / mm
<i>E. coli</i>	10.2	± 0.72
<i>S. aureus</i>	11.1	± 0.63
<i>L. monocytogenes</i>	6.0	± 0.41
<i>P. aeruginosa</i>	7.5	± 0.55

(i) Which type of bacteria was least affected by fucoxanthin?

(1)

- ☐ **A** *E. coli*
- ☐ **B** *S. aureus*
- ☐

C *L. monocytogenes*

☒ **D** *P. aeruginosa*

(ii) The table shows the mean and the range of the diameter of the zone of inhibition for each type of bacteria.

Calculate the maximum difference in the diameter of the largest and smallest zones of inhibition.

(1)

Answer mm

(d) Drugs containing these chemicals must be tested for safety before they can be approved and used to treat humans.

Three-phase testing can be used to check for the safety and effectiveness of these chemicals.

Describe the roles of phase I and phase II.

(3)

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(Total for question = 9 marks)

Q22.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Brazil is the largest producer of sugarcane.

The photograph shows sugarcane plants growing in Brazil.



(Source: © jeep2499/Shutterstock)

(a) Products from sugarcane, such as starch and cellulose, are used to make bioplastic.

(i) How many of the following statements about **starch** are correct?

- contains α -glucose and β -glucose molecules
- contains amylose and amylopectin
- stored in the tonoplast

(1)

☐ **A** none

☐ **B** one

☐ **C** two

☐ **D** three

(ii) How many of the following statements about a **cellulose** molecule are correct?

- contains α -glucose and β -glucose molecules
- contains 1,4 glycosidic bonds
- forms hydrogen bonds with other cellulose molecules

(1)

☐ **A** none

☐ **B** one

☐ **C** two

☐ **D** three

(b) Bioplastic bags made from sugarcane take up to six months to decompose.

Bacteria secrete enzymes onto the bags during the process of decomposition.

(i) Name **two** structures found in bacterial cells that are involved in the synthesis of these enzymes.

(1)

1

2

(ii) Decomposition of bioplastic bags occurs faster if there is increased bacterial growth.

Explain the conditions needed for increased bacterial growth.

(3)

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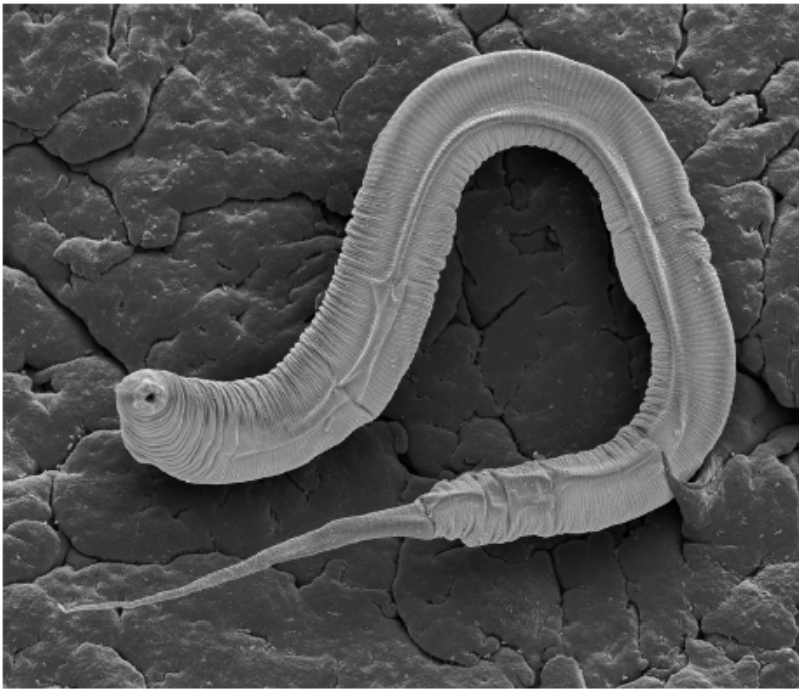
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(Total for question = 6 marks)

Q23.

Variation between organisms occurs as a result of sexual reproduction and epigenetic modification.

The photograph shows a nematode, as seen using an electron microscope.



(Source: © Leonid Serebrennikov / Alamy Stock Photo)

* (a) Animals of this species are either male or hermaphrodites.

Nematodes that inherit one sex chromosome are male.

Nematodes that inherit two sex chromosomes are hermaphrodites.

Hermaphrodites can produce both egg cells and sperm. Approximately 300 sperm are produced first and stored inside the nematode. After this, egg cells are produced.

The sperm of a hermaphrodite nematode can fertilise its own egg cells. This is called self-fertilisation.

However, when a hermaphrodite nematode mates with a male nematode, the sperm of the male fertilises the egg cells. This results in 700 more egg cells being fertilised than when a hermaphrodite self-fertilises. Half of these fertilised egg cells will result in male offspring.

Explain how the reproductive behaviour of these nematodes increases their chance of survival.

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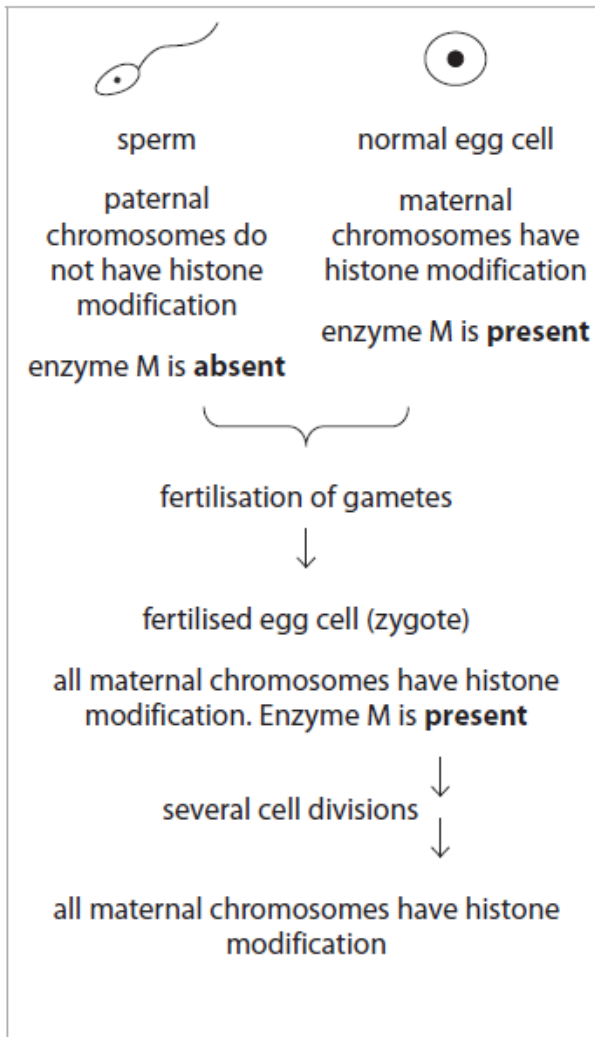
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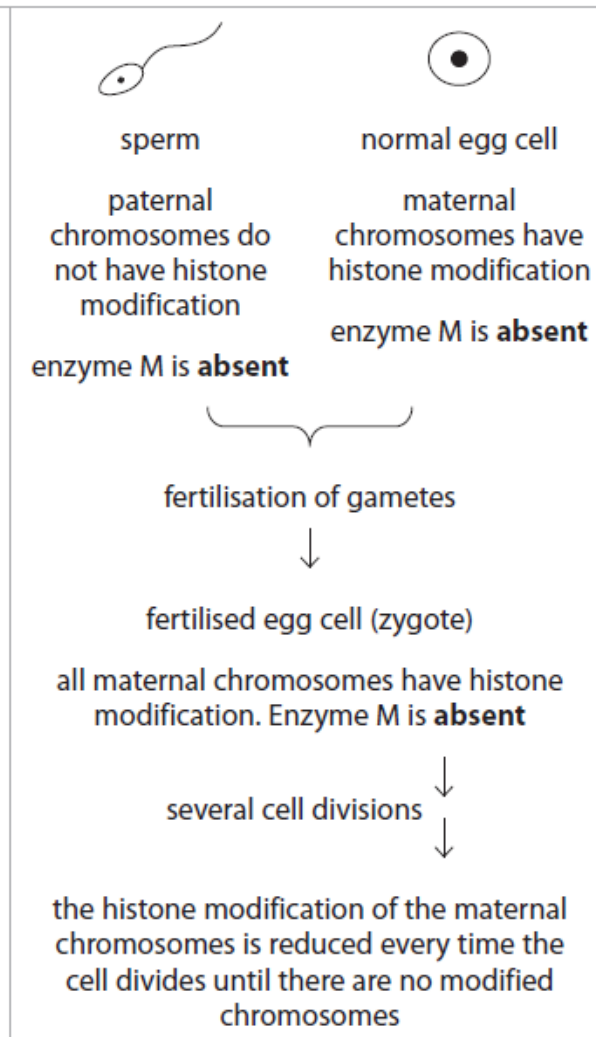
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(b) In nematodes, histone modification can be passed onto embryos.
Enzyme M causes this modification.
The diagram shows two experiments that demonstrated this.

Experiment 1



Experiment 2



Deduce how histone modification can be passed onto embryos.

(5)

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(Total for question = 11 marks)

Q24.

Meiosis increases genetic variation through independent assortment and crossing over.

(a) (i) In which stage of meiosis does independent assortment occur?

(1)

- ☐ **A** metaphase I
- ☐ **B** metaphase II
- ☐ **C** telophase I
- ☐ **D** telophase II

(ii) In which stage of meiosis does crossing over occur?

(1)

- ☐ **A** metaphase I
- ☐

B metaphase II

☒ **C** prophase I

☒ **D** prophase II

(b) Genetic variation increases due to the production of new combinations of alleles.

A cell has gene A and gene B with alleles A, a and B, b.

Meiosis could produce the following percentages of gametes containing the combinations of alleles shown in the table.

Combination of alleles	Percentage of total gametes produced (%)
AB	48
Ab	2
aB	2
ab	48

Explain why the percentages are not 25% for each combination of alleles.

(3)

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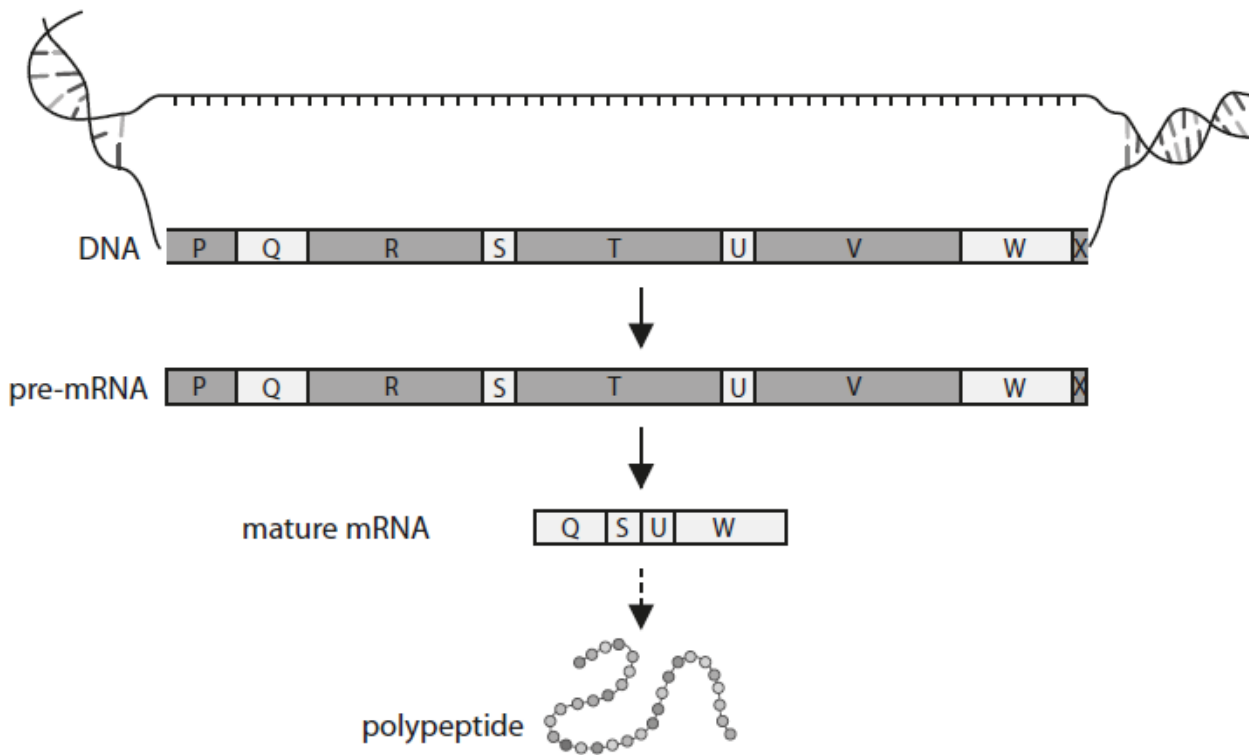
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(c) More than one type of protein can be synthesised from the RNA produced from one gene.

The diagram shows parts of this process.



Describe how more than one type of protein can be synthesised from the RNA produced from one gene.

Use the information in the diagram to support your answer.

(5)

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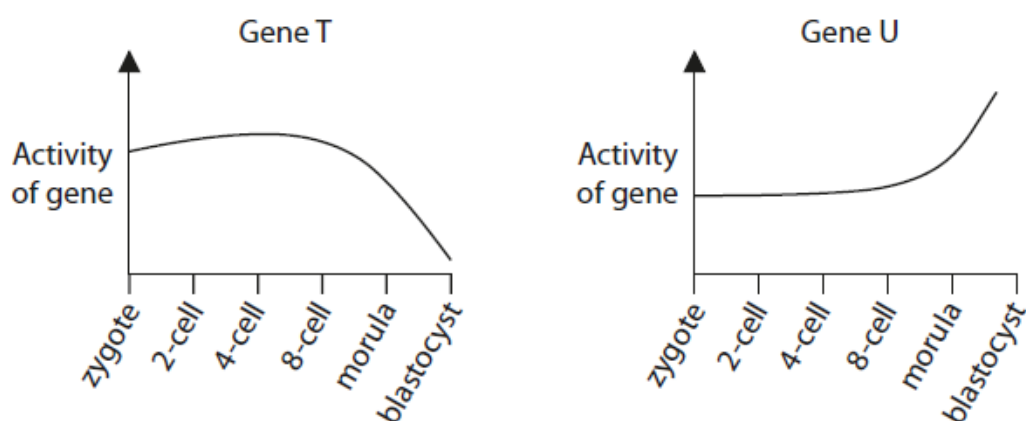
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(d) The graphs show the activity of two genes, T and U, as a mouse zygote (fertilised egg cell) develops into a blastocyst.



Comment on the changes in the activity of these two genes.

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(Total for question = 13 marks)

Q25.

Mitosis and the cell cycle are involved in producing new cells.

(a) Describe the role of the cell cycle in producing new cells.

(3)

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(b) Uncontrolled cell division can result in the formation of a tumour.

The RB gene is a tumour suppressor gene.

The RB protein produced from this gene inhibits tumour growth.

Lung cancer can occur when this gene has increased methylation compared with the RB gene in normal lung cells.

Explain why increased methylation of this gene could cause the growth of a tumour.

(4)

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(c) The cell cycle can be affected by various chemicals.

One drug, used to treat various types of cancer, prevents the shortening of spindle fibres.

Explain how preventing the shortening of spindle fibres affects mitosis.

(2)

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* (d) Paclitaxel is a drug used to treat some tumours.

In one study, the effect of paclitaxel on the cell cycle in human lung tumours was investigated.

The table shows the results of this study.

Concentration of paclitaxel / nmol dm ⁻³	Duration of mitosis / hours	Mitotic index of cancerous cells in lung tissue (%)
0	1	2
10	4	17
100	9	38
1 000	21	48
10 000	24	59

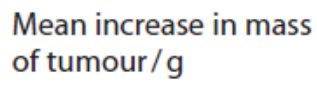
In another study, the effect of paclitaxel on the growth of breast tumours in mice was investigated. The effect of paclitaxel was compared with drug X and with a placebo.

For each group the increase in mass of the tumour was measured 21 days after starting treatment.

Three groups of mice with breast tumours were given the following treatments:

- Group 1 received a placebo
- Group 2 received drug X
- Group 3 received paclitaxel.

The graph shows the results from this study.



Use the information given to support your answer.

This image shows a full page of a notebook or worksheet template. It consists of a white background with approximately 20 evenly spaced, horizontal dashed lines running across the entire width of the page. There are no margins, text, or other markings present.

(Total for question = 15 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following: - named nitrogen containing compound synthesised (1) - credit role of this compound in the plant (1)	e.g. amino acids / proteins / nucleic acids / ATP / NADP e.g. {Proteins/ (peptide) hormones} are needed for {growth / repair} / DNA is needed for protein synthesis Ignore amino acids needed to form proteins Ignore nucleotides needed to form DNA/RNA	(2)

Question Number	Answer	Additional guidance	Mark
(b)	A description that makes reference to two of the following: - modification of protein (into enzyme) (1) - enzyme(s) packaged into (secretory) vesicles (1) - enzyme(s) leave cell by exocytosis (1)	Accept vesicles fuse with cell (surface) membrane and release enzyme(s) outside cell	(2)

Question Number	Answer	Additional guidance	Mark
(c)	<pre> graph TD A[Tested on human cells / animals] --> B[Phase 1 Tested on healthy volunteers] B --> C[Results reviewed (by independent scientists)] C --> D[Phase 2 Tested on small group of volunteer patients with the disease / HIV / cancer(s)] D --> E[Phase 3 Tested on 1000 to 3000 volunteer patients with the disease] </pre>	Accept identification of side effects Ignore identification of appropriate dosage Accept tested on 100-500 volunteer patients with {disease / HIV/ cancer} Ignore patients unqualified	(3)

Q2.

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes four of the following points: - cortical granules are released (from the egg cell) (1) - cortical granules fuse with the {zona pellucida / egg cell membrane} (1) - cortical granules release {chemicals / enzymes / proteins} to cause the hardening of zona pellucida (1) - prevents more than one sperm (cell) entering the egg cell (1) - egg cell and sperm nuclei are haploid and they fuse (during fertilisation) (1)	ACCEPT prevents polyspermy	(4)

Question Number	Answer
* (b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. <u>length of middle region</u> • increased length of mid region size increases swimming speed (I) • due to more mitochondria supplying more {energy/ ATP} to move the flagella (I) • increased chance of that male's sperm {reaching the egg cell(s) first / fertilising the egg cell(s)} / reproductive success for that male} (R) • selection pressure / males with alleles for longer mid sections will have an advantage over other males (R) • more offspring will {have the same father/ inherit same alleles} (G) • leading to possible reduction in genetic diversity (G) • many males and many egg cells could lead to an increased genetic diversity of offspring (G) <u>spermatophore</u> • spermatophore contains sperm cells for fertilisation of egg (I) • nutrients will be used by female to produce {egg cells with more nutrients / more egg cells} (R) • {chemicals / pheromones} reduce chances of other males mating with the female (R) • increased chance of that male's sperm {reaching the egg cells(s) first / fertilising the egg cell(s)} / reproductive success for that male} (R) • more offspring will {have the same father/ inherit same alleles} (G) • leading to possible reduction in genetic diversity (G) <u>storage of sperm</u> • {fertilised eggs / offspring} can be produced in absence of a mate (I) • increased reproductive success for {that female / males that mated} (R) • increased chance that offspring will {have different father/ inherit different alleles} (G) • leading to possible increase in genetic diversity (G) • not mating with (new) males every year could reduce genetic diversity (G) (6)

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited number of the most important or relevant scientific factors from the data/information provided are synthesised. No judgement is made.	1 mark – either R or G for one mating strategy 2 marks – either R+G for one mating strategy OR either R or G for two mating strategies OR 1 mark - basic information (I) given 2 marks - basic information (I) given + 1 or 2 x {R or G}
Level 2	3-4	Some of the most important or relevant scientific factors from the data/information provided are synthesised. A limited accurate judgement is made.	3 marks – 3 x (R or G) considered 4 marks = 4 x (R or G) considered
Level 3	5-6	Most of the important or relevant scientific factors from the data/information provided are synthesised. A detailed and accurate judgement is made.	5 marks = either reproductive success for all strategies considered plus genetic diversity of two strategies considered OR genetic diversity for all strategies considered plus reproductive success of two strategies considered 6 marks genetic diversity and reproductive success considered for all strategies

Q3.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that includes at least one similarity and one difference: similarities: - both contain membrane bound organelles (1) - both contain a {cell membrane / cell wall} (1) max 2 differences: - plant cell wall is composed of cellulose whereas a fungal cellwall is composed of chitin (1) - fungal cells contain glycogen granules whereas plant cells contain {starch grains / amyloplasts} (1) - plant cells contain {chloroplasts / plasmodesmata /tonoplast} whereas fungal cells do not (1)	ACCEPT named organelle(s) e.g. nucleus,mitochondria, 80S ribosomes etc ACCEPT both contain DNA associated with histones (1) ACCEPT fungal cells contain lysosomes whereas plant cells do not / plant vacuole may be larger than fungal vacuole	(3)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to four of the following points: - reduction in growth (1) and any three from: - due to reduced {cell division / mitosis} (1) - reduced gene expression will cause reduction in {enzyme/ protein} production (1) - reduced phospholipids which are needed for (growth of) {cell /organelle} membranes (in daughter cells) (1) - reduced transport of sucrose (around the plant) in the phloem /reduced sucrose available for other plant cells (1)	ACCEPT reduced DNA synthesis results in fewer cells in S phase / not enough DNA produced for mitosis to occur ACCEPT named enzyme e.g. DNA polymerase ACCEPT correct examples of sucrose use by plant e.g. reduced {respiration / ATP production}	(4)

Question Number	Answer
* (b)(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Description of data</u> - infection with fungus results in increased {tannin/ flavonoid} production - increasing the concentration of tannin reduces the leaf damage from herbivores - negative correlation / linear decrease - increasing the concentration of flavonoids increases the diameter of inhibition zone - doubling the concentration of flavonoids increases the diameter of inhibition zone by 28.6% <u>Plant</u> - explanation of how tannins reduce leaf damage e.g. herbivores don't like the taste / toxic / poisonous therefore less likely to eat the plant (A) - more leaves for photosynthesis and therefore increased growth (A) - explanation of what the diameter of inhibition zone shows = link to bactericidal/ bacteriostatic effect of flavonoids (A) - reduced plant infections (A) - link to why reduced herbivory and reduced plant infection benefits the infected plant e.g. fewer resources goes into growing new leaves and more can go into sexual reproduction (A) - disadvantage for plant – increased fungal growth (D) - more resources required {to produce tannins / for gene expression} instead of being used for {growth / sexualreproduction} (D) <u>Fungus</u> - link to why reduced herbivory benefits the fungus e.g. reduced competition for plant resources from herbivores, more plant resources available to fungus (A) - link to why reduced plant infection benefits the fungus e.g. reduced competition for plant resources from {bacteria / other fungi} (A) - reduced resources for fungus from plant as more used to synthesise tannins / flavonoids (D)

		the fungus might only be able to {influence / live in / complete life cycle in} dandelion plants (D)	(6)
			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	Information from one section
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	level one content plus consideration of advantage(s) and / or disadvantage(s) 5 marks = L1 + one from {FA / FD / PA / PD} 6 marks = L1 + two from {FA / FD / PA / PD} FA = fungal advantage FD = fungal disadvantage PA = plant advantage PD = plant disadvantage

Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Information from three sections applied to the given context showing a good understanding of the advantages and disadvantages to the infected plant and to the fungus 7 marks = L2 + three from {FA / FD / PA / PD} 6 marks – all four of {FA / FD / PA / PD} discussed
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Question Number	Answer	Additional guidance	Mark
(b)(iii)	A description that includes reference to the following points: (flavonoid drug) tested on small numbers of patients with {<i>P. aeruginosa</i> / lung infection} (1) - use of double-blind trial (1)	ACCEPT tested on {100 to 500} of patients with {<i>P. aeruginosa</i> / lung infection} ACCEPT placebo / established drug treatment	(2)

Q4.

Question Number	Answer	Mark
(a)(i)	The only correct answer is C two <i>A is not correct because there is one maternal and one paternal chromosome with three gene loci</i> <i>B is not correct because there is one maternal and one paternal chromosome with three gene loci</i> <i>D is not correct because there is one maternal and one paternal chromosome with three gene loci</i>	(1)

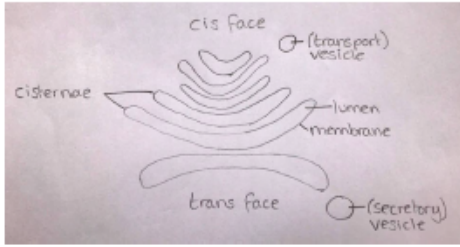
Question Number	Answer	Additional guidance	Mark
(a)(ii)	A description that makes reference to the following points: • uncoiling (of chromosome) (1) • used in protein synthesis / DNA replication (in S phase) (1)	Accept correct reference to histones / to form chromatin Accept transcription	(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	• prophase I		(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	The only correct answer is C three <i>A is not correct because ABe could not be formed by one chiasmata</i> <i>B is not correct because ABe could not be formed by one chiasmata</i> <i>D is not correct because ABe could not be formed by one chiasmata</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that makes reference to two of the following points: • alleles b and e are closer together (1) • therefore {crossing over / chiasma} is less likely to occur between these alleles (1)	Accept converse for A and E Accept converse for A and E	(2)

Q5.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following points: - at least two curved cisternae drawn (without ribosomes or interconnections) (1) - vesicle drawn (1) - cisternae labelled (1) - second correct label (1)	<u>Example of diagram</u> 	(4)

Question Number	Answer	Mark
(a)(ii)	The only correct answer is C two <i>A is not correct because the Golgi apparatus is involved in the formation of extracellular enzymes and modification of proteins</i> <i>B is not correct because the Golgi apparatus is involved in the formation of extracellular enzymes and modification of proteins</i> <i>D is not correct because the Golgi apparatus does not form peptide bonds</i>	(1)

Question Number	Answer	Mark
(a)(iii)	The only correct answer is D ribosomes <i>A is not correct because the ribosomes would become radioactive first</i> <i>B is not correct because the ribosomes would become radioactive first</i> <i>D is not correct because the ribosomes would become radioactive first</i>	(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	120(%) / 54.5(%) / 54(%) / 55(%)	<u>Example of calculation</u> $\frac{0.5 - 1.1}{0.5} \times 100$	(1)

Question Number	Answer	Mark
(b)(ii)	The only correct answer is B interphase <i>A is not correct because the Golgi apparatus would increase in size in interphase</i> <i>C is not correct because the Golgi apparatus would increase in size in interphase</i> <i>D is not correct because the Golgi apparatus would increase in size in interphase</i>	(1)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An answer that makes reference to four of the following points: - mitosis / two cells formed from one cell (1) - therefore {number / size} of Golgi (in each cell) has to increase(in interphase / G1) (1) - to provide enough cell {contents / organelles} for two (daughter) cells (after mitosis has occurred) (1) - because increased {protein synthesis / protein modification / gene expression} will occur (in interphase) (1) - because named protein(s) are required (by the cell) (1)	Accept relationship between {number/size}of Golgi and level of protein synthesis e.g. enzymes, hormones, structural proteins	(4)

Q6.

Question Number	Answer	Additional guidance	Mark
(a)(i)	A calculation in which: - conversion of actual length of scale into nm (1) - actual length divided by the given length (answer given to 2 significant figures and in standard form) (1)	<u>Example of calculation:</u> 30mm = 30 000 000 nm $30\,000\,000 \div 1200 = \times 2.5 \times 10^4$ accept +/- 1mm for length of bar	(2)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that makes reference to two of the following points: • electron microscope (1) • due to high magnification (1)	ecf from 2(a)(i) applies Accept high resolution Accept converse for light microscope Accept 3D image if qualified as scanning electron microscope	(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that makes reference to the following points: • presence of {(peptidoglycan) cell wall / circular chromosome(s) / DNA associated with histones / 70S ribosomes / RNA polymerase} (1) • absence of {nucleus / membrane bound organelles} (1)	Accept ether bonds	(2)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that makes reference to three of the following points: • (analysis of) molecular evidence (1) • to identify similarities and differences in biological molecules / comparison of biological molecules (1) • (analysis of) phenotype (1) • to identify similarities and differences between the two microorganisms (phenotype) (1)	e.g. DNA, mRNA, proteins, enzymes e.g. cell structure / anatomical features, grow in different {habitats/ conditions} e.g. named similarities and differences in cell structure	(3)

Q7.

Question Number	Answer	Additional guidance	Mark
(a)	A calculation in which: • calculation of volume of liposome (1) • expressed in standard form (1)	<u>Example of calculation:</u> 220893 $2 \times 10^5 / 2.2 \times 10^5 / 2.21 \times 10^5 \text{ (nm}^3\text{)}$ answer given to 3 sig fig ecf applied for mp2 for correct volume calculation using 75 as radius	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following points: Similarities • both are single-stranded (1) • both contain the bases A,U,C,G / both contain a base, phosphate group and ribose (sugar) / both contain phosphodiester bonds (1) • an exon on pre-mRNA contains same base sequence as the matching exon on active mRNA (1) Differences • pre-mRNA contains both introns and exons whereas active RNA only contains exons (1) • active mRNA may have {fewer / different order of} exons (than pre-mRNA) (1)	ACCEPT linear ACCEPT both do not contain thymine ACCEPT both contain RNA nucleotides / both contain uracil ACCEPT both contain exons ACCEPT pre-mRNA contains introns whereas active RNA does not ACCEPT pre-mRNA is {longer / has more bases} than active mRNA ACCEPT pre-mRNA has recognition site for spliceosome whereas active RNA does not ACCEPT active mRNA has a different base sequence to pre-mRNA	(4)

Question Number	Answer	Additional guidance	Mark
(a)(I)	The only correct answer is C Eukarya <i>A is incorrect because plants are found in the domain Eukarya</i> <i>B is incorrect because plants are found in the domain Eukarya</i> <i>D is incorrect because plants are found in the domain Eukarya</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(II)	A description that makes reference to the following: • (evidence from) molecular phylogeny (1) • identification of (similarities / differences) in (DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components) (1)	Accept comparing (DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components) Ignore (looking at / analysing) the (DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components / genetic makeup)	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • (tube) grows (through style) to (ovary / ovule / egg cell) / transports the (male nuclei / generative nucleus / male gametes) to (ovary / ovule / egg cell) (1) • (and secretes) digestive enzymes used to aid growth of tube (to ovule) (1) • (therefore) male nuclei can fuse with (egg cell (nucleus) / polar nuclei) (1)	Ignore micropyle Accept forms pathway to reach (ovary / ovule / egg cell) Accept enzymes digest through the style Accept fertilisation occurs to form (zygote / endosperm) Accept double fertilisation occurs / zygote and endosperm formed	(3)

Question Number	Answer	Additional guidance	Mark
(c)(I)	An answer that makes reference to the following: • as the Verapamil concentration increases the length of the pollen tube decreases (1) • credit a correct manipulated mathematical statement (1)	Accept negative correlation	(2)

Question Number	Answer	Additional guidance	Mark
(c)(II)	An answer that makes reference to the following: • lower concentration of calcium ions (in the cells) (1) • fewer {pectin / calcium pectate} molecules formed (1) • therefore increased flexibility of {microfibrils / cellulose} (due to fewer {pectin / calcium pectate} molecules) (1)	Accept no calcium ions present (in the cells) Accept calcium (ions) needed to produce {pectin / calcium pectate} Accept {calcium pectate / pectin} (are needed to) hold {microfibrils / cellulose} together (in a matrix) Accept {microfibrils / cellulose} are not held together by {calcium pectate / pectin} Accept calcium pectate helps middle lamella to hold adjacent cell walls together	(3)

Q9.

Question Number	Answer	Additional guidance	Mark
(a)	• anatomical • behavioural		(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	electron (microscope)		(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	A description that includes the following points: • aerobic respiration (1) • produce ATP (1) • for cell metabolism / named cell process (1)	Accept {Krebs / citric acid} cycle / oxidative phosphorylation accept cell {reactions / processes} / named process e.g. mitosis, protein synthesis, muscle contraction, active transport etc accept contains ribosomes for protein synthesis	(3)

Question Number	Answer	Additional guidance	Mark
(c)	An answer showing: - at least two tubules with ribosomes on surface (1) {cisternae / membrane} labelled (1) - ribosomes labelled (1)	Accept tubules ignore cell membrane	(3)

Q10.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is D animal, plant and prokaryotic cells <i>A is not correct because all three cell types contain a cell membrane</i> <i>B is not correct because all three cell types contain a cell membrane</i> <i>C is not correct because all three cell types contain a cell membrane</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C plant and prokaryotic cells only <i>A is not correct because prokaryotic cells contain a cell wall</i> <i>B is not correct because animal cells do not contain a cell wall</i> <i>D is not correct because animal cells do not contain a cell wall</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	A calculation in which: - cell diameter measured and converted into micrometres (1) - diameter divided by 25 with no units (1) OR 25 converted to mm - diameter divided by 0.025 with no units	<u>Example of calculation:</u> 42mm=42000 µm 42000 ÷ 25 = x1680 ecf for ±1mm and incorrect conversions Correct answer with no units and with no working scores full marks	(2)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes one of the following points: (site of) photosynthesis / converts light energy to {chemical energy / ATP} (1)	ACCEPT formation of correct named product of photosynthesis e.g. glucose ignore makes food	(1)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes the following point: this organism has a nucleus / prokaryotic cells do not contain a nucleus (1)	DO NOT ACCEPT cell membrane / cytoplasm ignore contains membrane bound organelles	(1)

Question Number	Answer	Additional guidance	Mark
(c)(i)	plasmodesma / plasmodesmata (1)		(1)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes the following points: - communication between / connects (connected) cells (1) - therefore signalling substances pass through {symplast / cytoplasm} / cytoplasmic streaming / transport of suitable named molecules e.g. minerals, water, glucose, amino acids, proteins, RNA (1)	allow ECF for pits, cell wall and middle lamella only pits - communication between / connects (connected) cells - therefore transport of suitable named molecules cell wall (sieve like network made of) cellulose fibres support the cell - therefore helps retain rigid structure / prevent cell lysis middle lamella - joins (adjacent) cell (walls) together - therefore increases {strength / stability} of {plant / cell (wall)}	(2)

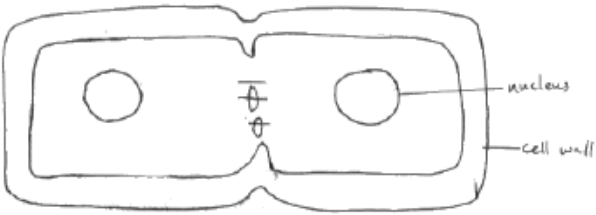
Q11.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B K <i>A is not correct because the DNA content is not doubling</i> <i>C is not correct because the DNA content is not doubling</i> <i>D is not correct because the DNA content is not doubling</i>	(1)

Question Number	Answer	Mark
(ii)	The only correct answer is B L <i>A is not correct because the chromosomes are not condensing</i> <i>C is not correct because condensation of chromosomes would have completed before metaphase begins</i> <i>D is not correct because the chromosomes are not condensing</i>	(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	prophase		(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that makes reference to two of the following points: - the {attachment/binding} of centromeres (to the spindle fibres) (1) - to allow the separation of the {(daughter) chromatids / chromosomes} (1) - so that each daughter cell gets identical genetic material (1)	ignore sister ACCEPT contract to move {chromatids / chromosomes} to opposite {poles/ends of cell} ACCEPT same number of chromosomes	(2)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An answer that makes reference to the following points: - cell wall and nuclear envelopes {present / reforming} (1) - cell plate visible (1)	<u>Example of diagram</u>  cell wall either labelled or cell has two outer lines ACCEPT phragmoplast	(2)

Question Number	Answer	Additional guidance	Mark
(c)	A description that makes reference to the following: - count number of cells in mitosis and the total number of cells (1) - divide the number of cells in mitosis by the total number of cells in the photograph (then multiply the answer by 100) (1)	ACCEPT named stages of mitosis ACCEPT correct equation	(2)

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes four of the following points: • water for {hydrolysis reactions / form cytoplasm / solvent / hydration} (1) • (some bacteria require) oxygen for (aerobic) respiration (1) • (suitable/optimum) temperature for {enzyme-controlled / metabolic} reactions to occur (at suitable rate) (1) • (suitable/optimum) pH for {enzyme-controlled / metabolic} reactions to occur (at suitable rate) (1) • named organic molecule and an explanation of why that organic molecule is needed (1)	ACCEPT (some anaerobic bacteria require) no oxygen for anaerobic respiration ACCEPT (suitable) temperature so enzymes do not denature ACCEPT (suitable) pH so enzymes do not denature e.g. glucose for respiration / lipids to provide fatty acid chains for new cell membrane / proteins to provide amino acids for {protein synthesis / growth}	(4)

Question Number	Answer	Additional guidance	Mark
(b)(i)	A calculation showing the following steps: • calculation of difference in mean area of ulcer (1) • calculation of percentage decrease (1)	<u>Example of calculation</u> $(802.71 - 95.71) = 707$ $\frac{(802.71 - 95.71)}{802.71} \times 100 = 88 / 88.077 / 88.08 / 88.1 (\%)$ Correct answer with no working shown scores full marks	(2)

Question Number	Answer	
(b)(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Description of data in table</u> • mass of mucus • ulcer area <u>Conclusions and Explanations</u> • omeprazole was most effective treatment /none of the extracts were as effective as omeprazole at reducing ulcer area / all treatments resulted in {reduction of ulcer area / increased mass of mucus} • correlation between mucus mass and ulcer area (apart from omeprazole) • bacteria damage stomach lining causing ulcers • suggestion that {omeprazole / extract} increases mucus production • high mucus content prevents bacteria {reaching / damaging} stomach lining • explanation of how mucus production links to ulcer area • high mucus content prevents acid contents damaging stomach lining <u>Sustained</u> • link to biological process resulting in increased mucus production • {omeprazole / extract} causes the {stomach lining / goblet cells} increases mucus production • suggestion that {omeprazole / extract} reduces acidity of stomach making it less suitable for <i>H. pylori</i> • antimicrobial properties of {omeprazole / extract} reducing {number / reproduction} of bacteria • therefore {slow population growth / reduced population of bacteria} results in {reduced damage to stomach lining / smaller ulcer area}	(6)

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information. The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.	Either Description of: mass of mucus data and/or ulcer area data OR description of one and/or conclusion / explanation of one data set
Level 2	3-4	An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning, with some structure.	description of both data plus: explanation of mass of mucus / ulcer area and/or simple conclusion of most effective treatment
Level 3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.	all level 2 plus: a detailed explanation using sustained application. The detail of sustained application determines the mark in this level.

Q13.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following point: group of (similar) cells (working together to) perform a (specific) function (1)	ACCEPT cells with similar {structure / function / origin}	(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following points: - patient P has a mitotic index of 20 (1) - patient R has a mitotic index of 45 (1) - correct order of cancer stage identified (1)	e.g. P has an earlier stage of cancer (than R), R has a more advanced stage of cancer ACCEPT ecf from calculated MI for P and R	(3)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes at least one similarity and one difference: similarity: - the survival probability decreases over time (for all three stages) (1) differences: - stage I has the highest survival probability for all years whereas stage IV has the lowest probability for all years (1) - stage IV has the {fastest/steeper} decrease (in survival probability) / stage I has the slowest decrease (in survival probability) (1)	ACCEPT correct order of survival probability for a point on the graph	(3)

Question Number	Answer	Additional guidance	Mark
(c)	A description that includes the following points: - correct description of a placebo being given to one group (and the other group receiving (anticancer) drug) (1) - neither the patient nor the doctor knows whether the patient is receiving (the drug or) the placebo (1)	ACCEPT description of a placebo e.g. has no active ingredient / already known drug / sugar pill / dummy drug ACCEPT scientist / researcher for doctor	(2)

Question number	Answer	Mark
(a)	{restricted / native} to a particular area	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	- subtraction (1) - percentage (1) Example of calculation: $5\,500 - 3\,000 / 2\,500$ $(2\,500 \div 5\,500) \times 100 = 45.45$	Accept 45.5 and 45	(2)

Question number	Answer	Mark
(b)(ii)	An explanation that includes three of the following points: - because of habitat destruction there is no food (1) - because of habitat destruction there is no shelter (1) - fragmentation of habitat makes it harder to find a mate (1) - therefore, there is a decrease in genetic diversity (1)	(3)

Question number	Answer	Mark
(c)(i)	A description that includes the following points: - sperm observed under a microscope to assess {motility / ability to swim in a straight line} (1) - use of {stains / microscope} to observe the integrity of the acrosome (1) - comparisons need to be made to freshly collected sperm so that effects can be calculated (1)	(3)

Question number	Answer	Mark
(c)(ii)	An explanation that includes any four of the following points: - because sperm can be frozen from different males to increase genetic diversity (1) - because frozen sperm will always be available if numbers of Baird's tapir decrease too far (1) - can freeze sperm so that they are available when females come in to season (1) - freezing could reduce the number of successful fertilisations because of poor viability (1) - more sperm would need to be used as viability is low, reducing stocks (1)	(4)

Q15.

Question Number	Answer	Additional guidance	Mark
(a)(I)	The only correct answer is C – plant cells and prokaryotic cells <i>A is incorrect because prokaryotic cells also have a cell wall</i> <i>B is incorrect because animal cells do not have a cell wall</i> <i>D is incorrect because animal cells do not have a cell wall</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(II)	Drawing (2): • {double (nuclear) membrane / nuclear envelope} obvious • nuclear pores shown and (1 or more) nucleoli present Labels (max 2): • (nuclear) envelope / <u>double</u> membrane / (<u>inner</u> / <u>outer</u>) (nuclear) membrane • (nuclear) pore • nucleolus • correct reference to chromatin / nucleoplasm	if one incorrect label, max of 1 label mark if two incorrect labels then no label marks can be awarded Ignore DNA	(4)

Question Number	Answer	Additional guidance	Mark
(b)(I)	An explanation that includes the following points: • the two {layers (of the membrane) / membranes} are very close together / there is a very small distance between the {two layers / membranes} (1) • therefore, the resolution of a light microscope is not high enough (1)	Accept the bilayer structure is very close together Ignore the bilayer is too {small / thin}	(2)

Question Number	Answer	Additional guidance	Mark
(b)(II)	A calculation showing the following steps: • length of XY measured correctly +/- 1mm (1) • calculation of actual size (1) • correct answer given in μm (1)	Mark the answer on answer line first <u>Example of calculation</u> 26 mm / 2.6 cm $26 \div 200 = 0.13 (\text{mm})$ $= 130 (\mu\text{m})$ Correct answer scores full marks	(3)

Question Number	Answer	Additional guidance	Mark
(b)(III)	A description that makes reference to the following: • form spindle {fibres / poles} in {prophase / mitosis / meiosis / cell division} (1) • to separate {chromosomes/ chromatids} (1)	Ignore DNA / genetic material	(2)

Q16.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following point: group of organs that work together to perform {one / one or more / specific} functions		(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that makes reference to the following point: group of (similar) cells working together to perform a (specific) function		(1)

Question Number	Answer					Mark
(b)(ii)	Structure	Propels male gamete towards female gamete	Modified by the action of cortical granules	Produce ATP by respiration	Contain linear DNA	(4)
	flagellum	☒ A				
	mitochondria			☒ C		
	nucleus				☒ D	
	zona pellucida		☒ B			

Q17.

Question Number	Answer	Mark
(a)	The only correct answer is C Y <i>A is not correct because W does not contain mitochondria</i> <i>B is not correct because X does not contain mitochondria</i> <i>D is not correct because Z does not contain mitochondria</i>	(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	A description that makes reference to the following points: - named organelle involved in protein production (1) - role of organelle described in the production of the enzyme (1)	mitochondria / nucleus / ribosomes / {rough endoplasmic reticulum / rER} / Golgi (apparatus/body) e.g. mitochondria – produce ATP for protein synthesis (of enzyme) nucleus – site of transcription of enzyme gene / location of gene for enzyme ribosomes -site of protein synthesis / where polypeptide is formed rER -site of protein synthesis / where polypeptide is formed / formation of 3° structure / packaging protein into (transport) vesicle Golgi apparatus – modification of {protein / enzyme} / packaging {protein / enzyme} into (secretory) vesicle	(2)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	800		(1)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that makes reference to four of the following points: - doubling the acrosin activity of the sperm cell increases the percentage of egg cells fertilised by 68% / non-linear increase (because) higher acrosin activity means the sperm cells can digest through all of the {outer layer / zona pellucida} (of more egg cells) (1) (allowing) sperm (cells) to {bind to (egg cell) membrane / enter egg (cell)} (1) (so that) sperm nucleus can fuse with egg (cell) nucleus / fusion (of nuclei) can occur (1) (low acrosin activity) could result in death of sperm cells before fertilisation could occur (1)	ACCEPT greater increase (in percentage of egg cells fertilised) between 2.5 and 3(a.u.) ACCEPT 100% fertilisation at 5(a.u.) compared to 32% at 2.5(a.u.) ACCEPT digesting the outer layer {faster / more efficiently} / more digestion occurs Accept converse ACCEPT sperm can reach egg (cell) nucleus ACCEPT sperm can fuse with egg (cell) ACCEPT converse	(4)

Question Number	Answer	Additional guidance	Mark
(c)(i)	image size divided by magnification	ACCEPT $4.5 \pm 1 \div 200$ ignore unmanipulated equation	(1)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An answer that makes reference to three of the following points: (when a sperm entered egg cell) cortical granules have fused to cell surface membrane / cortical {reaction/enzymes} resulted in hardening of zona pellucida (1) - as zona pellucida (of some egg cells) are damaged there are areas where it is not {present / hardened} (1) - resulting in polyspermy / {an extra / two} sperm have entered (the egg cell) (1)	ACCEPT some zona pellucida is not hardened reject 3 sperm have entered egg cell	(3)

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes two of the following points: - haploid so that when it is fertilised {a zygote is formed / it becomes diploid} (1) - contains lipid droplets as a source of energy (1) {cortical granules / enzymes} to {harden zona pellucida / prevent polyspermy} (1)	ACCEPT large cell to store more {lipid/energy} ACCEPT releases chemicals to attract sperm ACCEPT sperm bind to glycoproteins on egg cell (surface)	(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: Similarities - lining up of {chromosomes/ chromatids} on equator (of cell) (1) - centromere bonds to spindle fibres (in metaphase) (1) Differences (max 2): - two metaphase stages in meiosis whereas mitosis has one (1) {independent/random} assortment occurs (in metaphase I) in meiosis whereas it does not occur in mitosis (1) - meiosis involves homologous pairs of chromosomes (in metaphase I) and sister chromatids (in metaphase II) whereas mitosis involves sister chromatids (1)	Full marks can only be awarded if there is a similarity in the answer ACCEPT centre of cell / metaphase plate ACCEPT {chromosomes/chromatids} bond to spindle fibres ACCEPT independent assortment only occurs in metaphase I in meiosis ACCEPT meiosis involves pairs of chromosomes whereas mitosis involves pairs of {sister chromatids/single chromosomes} ACCEPT meiosis involves pairs of chromosomes whereas mitosis does not	(3)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes four of the following points: • morula cells are totipotent whereas blastocyst cells are pluripotent (1) • (specialisation / differentiation occurs because) gene(s) switched off (in blastocyst cells) (1) • due to {epigenetic modification / DNA methylation / histone modification} (1) • transcription of (active) genes to produce (active) mRNA / (active) mRNA translated at the ribosomes (1) • the protein(s) produced {determine / change} cell {structure / function} (1)	ACCEPT cells become pluripotent ACCEPT differential gene expression occurs ACCEPT transcription and translation of (active) gene to produce protein	(4)

Question Number	Answer	Additional guidance						Mark
(c)(i)	• correct D2 values (1) • correct calculation of $\sum D^2$ (1)	Age (weeks)	Rank	Mass of egg (g)	Rank	D	D ²	(2)
		36	1	2.27	8	-7	49	
		39	2	1.91	1	1	1	
		42	3	2.18	5.5	-2.5	6.25	
		45	4	2.28	9	-5	25	
		48	5	2.12	4	1	1	
		51	6	2.19	7	-1	1	
		54	7	2.18	5.5	1.5	2.25	
		57	8	2.09	3	5	25	
		60	9	2.03	2	7	49	
							159.5	
		$\sum D^2 = 159.5$ Correct answer with no working shown scores full marks 1 mark awarded for correct Σ using incorrect D ² values calculated in table						

Question Number	Answer	Additional guidance	Mark
(c)(ii)	- correct values substituted into formula (1) - correct r_s value (1)	Example of calculation: $957 \div 720$ $= -0.329 / -0.33 / -0.3$ Allow ECF from answer calculated in(c)(i) Correct answer with no workings shown scores full marks	(2)

Question Number	Answer	Additional guidance	Mark
(c)(iii)	An explanation that includes the following points: (the null hypothesis) should be accepted (1) (because) 0.38 is lower than 0.683 (1)	mark points independently	(2)

Q19.

Question Number	Answer	Additional guidance	Mark
(a)	A calculation showing the following steps: - correct difference (1) - correct percentage difference to 2 significant figures (1)	Mark the answer on answer line first <u>Example of calculation:</u> $170 - 105 = 65$ $(65 \div 105) \times 100 = 62\%$ Correct answer (62) with no working gains full marks Accept 38% for both marks	(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	The only correct answer is B $2.85 \times 10^{-3} \text{ (mm}^3\text{)}$ <i>A is not correct because that is the volume in cm^3</i> <i>C is not correct because that is not the volume in mm^3</i> <i>D is not correct because that is the volume in μm^3</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	Mouse Day 0 Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Human	accept circle without morula label accept morula label without circle	(1)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	A description that includes the following points: • fusion of cortical granules with cell (surface) membrane and release of enzymes (1) • hardening of zona pellucida (to prevent polyspermy) (1) • fusion of two haploid nuclei (to form diploid nucleus) (1)	Accept joining of two haploid nuclei	(3)

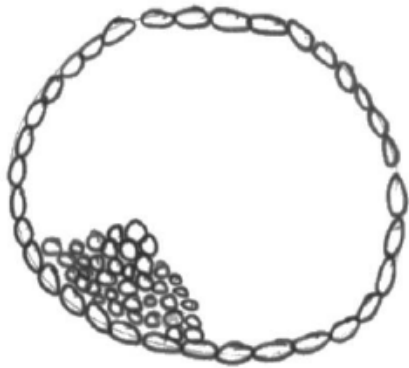
Question Number	Answer	Additional guidance	Mark
(c)	An answer that includes the following points: • it is a short distance between (mitochondria and lipid) (1) • quicker diffusion of {lipid / fatty acid / glycerol} (into mitochondria) (1) • lipids used in {respiration / ATP production} (1)	accept they are close together Accept (lipid droplets) converted to glucose ignore energy storage	(3)

Q20.

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that makes reference to the following: • (step A) mitosis (1) • (step B) meiosis (1)	accept meiosis I do not accept meiosis I ignore II	(2)

Question Number	Answer	Mark
(a)(ii)	The only correct answer is A W B is not correct because the acrosome contains digestive enzymes C is not correct because the acrosome contains digestive enzymes D is not correct because the acrosome contains digestive enzymes	(1)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • (because) differential gene expression occurs (1) • (due to) epigenetic modification / DNA methylation / histone modification (1) • {transcription of / (active) mRNA made from} active genes (1) • (therefore) translation occurs to form a {polypeptide / protein} (1) • (proteins cause) {structural/functional} change to cells to change them into (specialised) sperm cell (1)	Accept some genes become {switched on / expressed / switched off} Accept description of a {structural/functional} change into a sperm cell	(5)

Question Number	Answer	Additional guidance	Mark
(c)(i)	An answer that includes the following points: - outer layer of cells with internal cell mass (1) - cavity in centre of the diagram (1)	Example of diagram: 	(2)

Question Number	Answer	Mark
(c)(ii)	The only correct answer is D cells that can give rise to almost any type of cell in the body, excluding totipotent cells A is not correct because pluripotent do not give rise to all cells in the body B is not correct because pluripotent do not give rise to all cells in the body C is not correct because pluripotent do not give rise to totipotent cells	(1)

Question Number	Answer	Additional guidance	Mark
(d)	An answer that includes the following points: (stem cells) can {differentiate / specialise} into different {cells / tissues / organs} (1) - great {potential/ importance/ medical implications} of the research in developing medical therapies (1) - salamander embryos do not have a fully developed nervous system (1) - no need to use human embryos (1)	accept named example of a medical therapy use of stem cells in humans e.g. {repair / transplant} {cells / tissues / organs} in humans accept will save human lives / used to treat certain diseases e.g. cancer / heart disease accept salamander embryos do not feel pain / salamanders are not an endangered species / salamanders produce a large number of embryos	(2)

Q21.

Question Number	Answer	Additional guidance	Mark
(a)(i)	correct magnification calculated	ACCEPT range between $\times 14\,000$ - $\times 18\,000$ ACCEPT correct magnification in standard form	(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that makes reference to the following point: too small ($0.5\mu\text{m}$) to be viewed (under a light microscope) / magnification (of $\times 14\,000$-$16\,000$) can't be achieved by a light microscope / resolution would be too low} (1)	ecf applies ignore references to 3D image	(1)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that makes reference to two of the following points: - plant based packaging is (more) sustainable / biodegradable / carbon neutral (than traditional oil-based packaging) (1) (the antimicrobial property of the oregano oil) will {reduce the numbers of (<i>L. monocytogenes</i>) bacteria / prevent bacterial growth (on the food) / prevent microbial growth} (1) (resulting in) fewer people getting {listeriosis / (microbial) disease} (1)	ACCEPT plant-based packaging is {renewable / available for future generations} ACCEPT kill bacteria ignore reduce microbes entering packaging ACCEPT so food will not go off as quick / extends shelf life	(2)

Question Number	Answer	Mark
(c)(i)	The only correct answer is C <i>A is not correct because L. monocytogenes is least affected by the chemicals</i> <i>B is not correct because L. monocytogenes is least affected by the chemicals</i> <i>D is not correct because L. monocytogenes is least affected by the chemicals</i>	(1)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	6.14 / 6.1 / 6	<u>Example of calculation:</u> 11.1+0.63=11.73 6.0-0.41=5.59 11.73-5.59=6.14	(1)

Question Number	Answer	Additional guidance	Mark
(d)	A description that makes reference to the following points: - to test for side-effects (1) - to determine {safe / minimum / effective/ suitable} {dosage / concentration} (1) - to determine if it is more effective than {existing treatments / placebo} (1)	ignore to check for safety do not accept testing for side effects in context of {in-vitro/animal} ACCEPT to {determine optimum dosage / adjust dose} ACCEPT compare effectiveness with {existing treatments / placebo} ignore to see if it's effective	(3)

Q22.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is B one A is not correct because starch only contains α-glucose and is stored in amyloplast C is not correct because starch only contains α-glucose and is stored in amyloplast D is not correct because starch only contains α-glucose and is stored in amyloplast		(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C two <i>A is not correct because they are all correct apart from contains α-glucose and β-glucose</i> <i>B is not correct because they are all correct apart from contains α-glucose and β-glucose</i> <i>D is not correct because they are all correct apart from contains α-glucose and β-glucose</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	(bacterial) chromosome - and (70S) ribosomes	Both structures required for the mark Accept nucleoid / (circular) DNA / plasmid / (m)RNA ignore size of ribosome	(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes three of the following points: - oxygen for (aerobic) respiration (1) - glucose for respiration / amino acids for protein synthesis (1) - optimum temperature for (faster) {enzyme / metabolic} reaction (1) - optimum pH for (faster) {enzyme / metabolic} reaction (1)	accept lack of oxygen for survival of obligate anaerobes accept water for {hydrolysis reactions / solvent} accept suitable stated temperature for {faster/optimum} enzyme rate of reaction accept suitable stated pH for {faster/optimum} enzyme rate of reaction	(3)

Q23.

Question Number	Answer
* (a)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. - hermaphrodites can self-fertilise / reproduce without the need to find a mate - fertilising own egg cells using their own sperm cells - produce fewer nematode offspring - all offspring likely to be hermaphrodites - as all gametes will contain a sex chromosome - hermaphrodites can reproduce with a {mate / male nematode} / need to find a male to mate with - males have only one chromosome - if hermaphrodite mates with a male then (700) more egg cells are fertilised - half of the offspring will be {hermaphrodites / male} - if sperm cells without a sex chromosome fertilise an egg cell then the offspring will be male - if sperm cells with a sex chromosome fertilise an egg cell then the offspring will be hermaphrodites - half of the male sperm cells will not contain a sex chromosome - consideration of advantages of {reproducing without the need to find a mate/ all offspring being hermaphrodites} on chance of survival (of nematodes) - consideration of disadvantages of fewer offspring on chance of survival (of nematodes) - consideration of disadvantages of needing to find a mate reproducing on chance of survival of nematodes - consideration of advantages of more offspring on {increased reproductive success / chance of survival / increased future sexual reproduction} of nematode {population/species/offspring}

	- self-fertilisation leads to limited genetic variation (in offspring) / {decrease/no change} in gene pool {sexual reproduction / mating with male nematode} results in increased genetic variation of offspring - consideration of disadvantages of limited genetic variation on chance of survival (of nematodes) - consideration of advantages of increased genetic variation on chance of survival (of nematodes) - consideration of benefits of more offspring with increased genetic variation
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			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information. The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.	consideration of both types of reproductive behaviour from given information only or more detailed consideration of one type of reproductive behaviour
Level 2	3-4	An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning, with some structure.	all level 1 info plus consideration of two of -explanation of adv/disadv of asexual on survival of nematodes (not GD) -explanation of adv/disadv of sexual on survival of nematodes (not GD) -effect of reproductive behaviour on genetic diversity of offspring -explanation of impact of genetic diversity on survival of nematodes
Level 3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.	all level 2 info plus consideration of all of -explanation of adv/disadv of asexual on survival of nematodes (not GD) -explanation of adv/disadv of sexual on survival of nematodes (not GD) -effect of reproductive behaviour on genetic diversity of offspring -explanation of impact of genetic diversity on survival of nematodes

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: - histone modification can be passed onto zygotes (1) - if enzyme M is present, histone modification is passed on to {all chromosomes / embryo} (after cell division in experiment 1) (1) - cells divide by mitosis (1) - if enzyme M is absent (in the egg cell cytoplasm) then the histone modification decreases until no longer detected (1) (histone modification decreases because) replicated DNA can't be modified without enzyme (M) (1) - description of histone modification (1)	ACCEPT fertilised egg cells (in both experiments) have histone modification ACCEPT enzyme M causes histone modification ACCEPT histone modification is passed on to {all chromosomes/embryo} in experiment 1 ACCEPT cell division involves replication of DNA ACCEPT histone modification is not passed on to all chromosomes in experiment 2 ACCEPT enzyme M can't be produced (if absent in egg cell) ignore genes being switched {on/off}	(5)

Q24.

Question Number	Answer	Additional guidance	Mark
(a)(i)	A - Metaphase I The only correct answer is A <i>B is not correct because independent assortment does not occur in metaphase II</i> <i>C is not correct because independent assortment does not occur in telophase I</i> <i>D is not correct because independent assortment does not occur in telophase II</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	C - Prophase I The only correct answer is C <i>A is not correct because crossing over does not occur in metaphase I</i> <i>B is not correct because crossing over does not occur in metaphase II</i> <i>D is not correct because crossing over does not occur in prophase II</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • (due to) linkage (1) • A and B are on same chromosome (1) • {genes/ alleles / AB / ab / 48%} are not separated due to crossing over / {AB / ab} are inherited together (1) • {Ab / aB / 2%} formed by crossing over (1)	ACCEPT 25% due to A and B on separate chromosomes ACCEPT the closer together two loci are the smaller the chance of separation (by recombination) / ORA ACCEPT {Ab / aB} are recombinants	(3)

Question Number	Answer	Additional guidance	Mark
(c)	A description that includes the following points: • reference to post transcriptional changes / (pre-)RNA splicing (1) • {introns / P, R, T, V and X} removed by enzymes (1) • rearrangement of {exons / Q, S, U and W} / removal of some exons (1) • credit two different permutations of exon order given (1) • (therefore) a different {primary sequence / sequence of amino acids / polypeptide} (1)	ACCEPT spliceosomes ACCEPT not all exons used ACCEPT different sequence of amino acids can result in differences in {folding / bonding} giving a different protein (3D) shape	(5)

Question Number	Answer	Additional guidance	Mark
(d)	An answer that includes the following points: • (activity of) gene T decreases (during development) and gene U increases (1) • (because) gene T is switched off (1) • {product of gene T not needed / (gene T) protein not produced} once blastocyst stage reached (1) • product of gene U is needed at higher levels after the {8-cell / morula} stage (1)	ACCEPT pieced together ACCEPT description ACCEPT product of gene T not needed after 8-cell stage reached ACCEPT gene U is involved in specialisation of the cells / correct description of role of gene U protein	(3)

Q25.

Question Number	Answer	Additional guidance	Mark
(a)	A description which includes the following points: • synthesis of organelles (1) • increase in cell size / growth of cell (1) • {synthesis / replication} of DNA (1)	ignore references to G1, S and G2 accept {replication / increasing number} of organelles accept synthesis of {proteins / enzymes} required for the next part of the cell cycle accept increase in cytoplasm ignore growth of organelles accept {DNA / genetic material} is doubled	(3)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes four of the following points: • {methyl groups / CH₃} are added to {DNA / the gene/ cytosine} (1) • (resulting in RB) gene being {switched off / silenced} (1) • (methylation) prevents the binding of {RNA polymerase / transcription factors} (1) • (therefore) translation (of mRNA) does not occur (1) • (therefore the) {RB / tumour suppressor} protein isn't produced (1) • and {the cell cycle / mitosis} continues (forming a tumour) / {reduced / no} inhibition of tumour growth (1)	ignore methylation of the gene accept gene is not {expressed / active} accept {no / reduced} transcription of (RB) gene / mRNA is not produced (from RB gene) accept fewer {RB / tumour suppressor} proteins are produced accept higher rate of cell division occurs	(4)

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • (sister) chromatids cannot be separated / centromere cannot be split (1) • during anaphase (1)	accept chromosomes won't {be separated / move to poles of cell / move away from equator} accept cell remains in metaphase	(2)

Question Number	Answer
* (d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. • increasing concentration of Paclitaxel {increases the duration of mitosis / slows mitosis} • quantitative comparison using information from table • increasing concentration of Paclitaxel increases the mitotic index • quantitative comparison using information from table • Paclitaxel causes the lowest increase in mass of tumour / lowest mass of tumour with paclitaxel • Paclitaxel was more effective than {placebo / drug X} • quantitative comparison using information from graph • error bars for paclitaxel do not overlap with {drug X / placebo} so there is a significant difference / error bars for drug X and placebo overlap so {the data may not be completely reliable / have similar effectiveness} / correct comment about size of error bars linked to repeatability of data • recognition that there is a significant difference between {placebo/drug X} and paclitaxel data • relevant comment about study design e.g. sample size, no information about age/sex etc of volunteers, no given duration in human lung study, only 21 days in mouse study • paclitaxel stopped division of cancerous cells / {fewer / decreased rate of} cancer cells being produced with paclitaxel • linkage between {increased mitotic index/ slower rate of mitosis / fewer cancer cells produced by mitosis} and smaller mass of tumour • explanation of how mitotic index is calculated (number of cells in mitosis ÷ total number of cells) • linkage between the increased duration of mitosis and the increased mitotic index e.g. more cells in prophase, metaphase, anaphase, telophase than in interphase • linkage between prevention of shortening of spindle fibres and increased duration of mitosis/mitotic index • resulting in, fewer cells in {anaphase/telophase/cytokinesis} than {prophase/metaphase} (6)

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited scientific judgement made with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Basic evaluation of either the effectiveness of Paclitaxel on lung tumours in humans or the effectiveness of Paclitaxel on breast tumours in mice
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Basic evaluation of the effectiveness of Paclitaxel on lung tumours in humans and the effectiveness of Paclitaxel on breast tumours in mice OR detailed evaluation of either the effectiveness of Paclitaxel on lung tumours in humans or the effectiveness of Paclitaxel on breast tumours in mice
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Detailed evaluation of the effectiveness of Paclitaxel on lung tumours in humans and the effectiveness of Paclitaxel on breast tumours in mice

Q26.

Question Number	Answer	Additional guidance	Mark
(a)	C - C D B E A The only correct answer is C <i>A is not correct because the correct order is C D B E A</i> <i>B is not correct because the correct order is C D B E A</i> <i>D is not correct because the correct order is C D B E A</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes four of the following points: - DNA content remains constant during {G1 / G2/ mitosis} (1) - the DNA content doubles (1) - due to {DNA / chromosome} replication / S phase / replication (1) - the cell divides / cytokinesis (after 15 hours) (1) (therefore) it will produce (two) diploid (daughter) cells (1)	ACCEPT DNA content stays at 2 during G1 / DNA content stays at 4 during {G2 / mitosis} ACCEPT DNA content increases {to 4 / by 2} ignore interphase ignore telophase ACCEPT (therefore) it will produce (two) genetically identical (daughter) cells	(4)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: - similar shape graph as mitosis (1) - with a further division line to reduce DNA content to {haploid / 1 a.u.} (1)	<u>Example of graph</u>	(2)

Q27.

Question Number	Answer	Additional guidance	Mark
(a)	correct calculation of magnification	(40 ÷ 4.4 = 9.091) (x) 9.1 reject units	(1)

Question Number	Answer	Additional guidance	Mark
(b)	The only correct answer is B 0.20% <i>A is not correct because 0.20% of infected people died</i> <i>C is not correct because that is the percentage of infected people who survived</i> <i>D is not correct because 0.20% of infected people died</i>		(1)

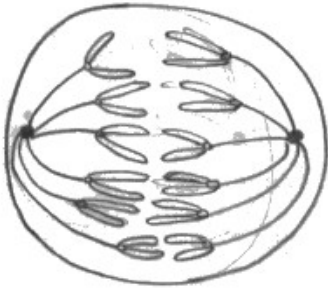
Question Number	Answer	Additional guidance	Mark
(c)(i)	produce ribosomal subunits	Accept produce ribosomes ignore contains genetic material	(1)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	A description that includes three from the following points: - plant cell would have {starch (grain) / amyloplast} (instead of glycogen granule) (1) - plant cell would have cell wall made from cellulose (not chitin)(1) - plant cell would contain {plasmodesmata / one nucleus} (whereas this cell does not) (1) - the plant cell vacuole would be larger (1)	ignore chloroplast accept plant cells do not have glycogen granules accept plant cell would have lignin accept plant cells do not have chitin cell wall ignore pores	(3)

Question Number	Answer
(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. • description of the table data e.g. comparison of numbers of mosquitoes {killed / survived} • consideration of GM fungus being most effective treatment • consideration that most mosquitoes were resistant to the insecticide used / some were not resistant to insecticide and were killed / inheritance of resistance • consideration that resistance arose due to mutation / natural selection / genetic variation in population • as gene is only {switched on / expressed} when the fungus has infected an <i>Anopheles</i> mosquito • the toxin is only produced when the fungus has infected an <i>Anopheles</i> mosquito • consideration of protein synthesis / detail of the role of rER and Golgi apparatus • evaluation of methodology / limitations of method e.g. mosquitoes escaping, small sample size • consideration of wider effects on biodiversity e.g. toxin will not poison other insects / humans / organisms whereas insecticides would kill other insects / effect on food chains / biodiversity

		transfer of (spider venom) gene to other fungal species	(6)
			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited scientific judgment made with a few strengths /weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	1 mark – description of results using table data.2 marks consideration of one from: consideration of most effective treatment resistance / inheritance of resistance mutation gene expression protein synthesis limitations of method biodiversity and transfer of gene to other fungi
Level 2	3-4	A scientific judgment is made through the application of relevant evidence, with strengths / weaknesses identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	all level one plus: 3 marks – two from list 4 marks – three from list consideration of: consideration of most effective treatment resistance / inheritance of resistance mutation gene expression protein synthesis limitations of method

			biodiversity and transfer of gene to other fungi
Level 3	5-6	A scientific judgment is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding, with evidence to support the judgement being made.	all level 2 content 5 marks – consideration of four from the list 6 marks – consideration of five from the list consideration of most effective treatment resistance / inheritance of resistance mutation gene expression protein synthesis limitations of method biodiversity and transfer of gene to other fungi

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that makes reference to the following points: - centrioles and spindle fibres shown (1) 6 chromosomes being pulled to each pole (1)	Example of diagram: 	(2)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	A calculation in which: - calculation of number of degrees per minute (1) - calculation of number of degrees (including unit) (1)	<u>Example of calculation:</u> $270 \div (9 \times 60) = 0.5^\circ$ $0.5 \times 20 = 10^\circ$ Correct answer scores full marks	(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	location of gene(s) on a(n Indian muntjac) chromosome	ACCEPT {nucleotide base pairs / allele} for gene ACCEPT chromatid for chromosome	(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that makes reference to the following points: (egg cells are) haploid (1) (egg cell chromosomes) have {an altered base sequence / different alleles} (than body cell chromosomes) (1) - due to {(random) mutations (during DNA replication) / crossing over / random assortment / independent assortment} (1)	ACCEPT contain {3 / half the number of} chromosomes do not accept genes ACCEPT chromosomes mutations due to errors in separation of {chromatids / chromosomes}	(3)

Question Number	Answer	Additional guidance	Mark
(c)	An answer that makes reference to two of the following points: • (because the parents are) different species (1) • (because {maternal and paternal / 3 and 23}) chromosomes would not pair up (1) • (therefore) cannot make {haploid / sperm / egg} cells (1)	ACCEPT because diploid number (of either species) could not be restored ignore parents have different number of chromosome pairs ACCEPT meiosis cannot occur	(2)

Q29.

Question number	Answer	Mark
(a)(i)	• Archaea	(1)

Question number	Answer	Mark
(a)(ii)	A diagram that includes any three of the following structures: • circular DNA (1) • plasmid (1) • (70S) ribosomes (1) • membrane (1) • flagellum (1) • pili (1) • capsule (1)	(3)

Question number	Answer	Mark
(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content • numbers of bacteria increase along the digestive system • <i>Veillonella</i> can tolerate only low pHs • <i>Streptococcus</i> found in pH 6 - 8 with reasonably high oxygen content • <i>Streptococcus</i> requires oxygen for aerobic respiration • <i>Enterobacterium</i> can tolerate low oxygen concentrations • <i>Enterobacterium</i> requires less ATP or can respire anaerobically • pH affects enzyme activity • pH affects the ionisation of R groups • small change in pH drastically affects enzyme activity	(6)

Level	Marks	Descriptor
	0	No awardable content.
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information. The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.
2	3-4	An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.
3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.

Q30.

Question Number	Answer	Additional guidance	Mark
(a)	A description that includes five from the following points: • (pollen) tube grows down (style) to {ovary / ovule / egg cell / micropyle} • (by releasing) {digestive / hydrolytic} enzymes (1) • the generative nucleus {divides / undergoes mitosis} • to form two {male / haploid} nuclei (1) • one {male / haploid} nucleus fertilises the egg cell (to form the zygote) (1) • one {male / haploid} nucleus fertilises the (two) polar nuclei to form the endosperm (nucleus) (1)	{Male / haploid} only needs to be stated once and then will apply for subsequent mp piece together mp1 Accept pollen tube transports {generative nucleus / male nuclei} down the style Accept male gamete / sperm nucleus Accept male gamete / sperm nucleus Accept female {nucleus / gamete} from egg cell Accept male gamete / sperm nucleus ignore polar nucleus (singular)	(5)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • each male nucleus and egg cell nucleus (from silver trumpet trees) is genetically different (from each other) / (each ovule) may have been fertilised by {pollen / gamete} from (many) different trees (1) • due to crossing over of {alleles / DNA} (between chromatids) / mutation (1) • due to {independent / random} assortment (of chromosomes) (1) • in meiosis (1)	accept each male and female gamete is genetically different (from each other) accept description of crossing over forming {recombinant chromatids / different combinations of alleles}	(4)

Q1.

The phenotype of an organism is affected by a number of factors.

(a) State what is meant by the term **phenotype**.

(1)

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(b) Coat colour in rabbits is determined by multiple alleles.

The table gives some information about coat colour in rabbits.

Type of rabbit	Coat colour of rabbit	
Black 	black all over	CC
Chinchilla 	grey all over	$c^{ch}c^{ch}$
Himalayan 	white body black ears, face, feet and tail	c^hc^h
Albino 	white all over	cc

(i) Complete this table by writing a suitable heading for the right-hand column.

(1)

(ii) Which row of the table gives the correct number of genes and alleles for coat colour in these rabbits?

(1)

	Number of genes for coat colour	Number of alleles for coat colour
☒ A	1	1
☒ B	1	4
☒ C	4	1
☒ D	4	4

(c) Height is one phenotype of an elephant.

The photograph shows an African elephant.



Source: Caroline Wilcox

Male African elephants range in height from 3.2 m to 4.0 m.

Female African elephants range in height from 2.2 m to 2.6 m.

(i) Which row of the table names the types of graph that should be drawn to show sex and height variation in a population of African elephants?

(1)

	Sex	Height
☒ A	bar chart	bar chart
☒ B	bar chart	histogram
☒ C	histogram	bar chart
☒ D	histogram	histogram

(ii) Calculate how many times bigger the male African elephant is than the female African elephant.

(2)

Answer

(Total for question = 6 marks)

Q2.

The phenotype of an organism is the result of interactions between the genotype and the environment.

Phenotypes can show continuous or discontinuous variation in a population.

(a) Sketch a graph to show the distribution for a phenotype showing continuous variation in a population.

(2)

(b) The presence or absence of teeth in chickens is one example of a discontinuous phenotype.

Chicken genomes contain the genes for tooth production, but chickens do not normally develop teeth.

These genes are switched off as the embryo develops.

Explain how a mutation could cause the development of teeth in a chicken embryo.

(4)

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(c) The photograph shows two Himalayan goats.



(Source: © Rainer Pauschert / Alamy Stock Photo)

The fur colour of a goat depends on its genotype.

Gene B controls fur colour in these goats.

The allele for brown fur is dominant to the allele for white fur in goats.

The allele **B** codes for brown fur and the allele **b** codes for white fur.

In one population, there were 470 brown goats and 140 white goats.

Calculate the frequency of the allele **B** in this population, using the equation

$$p^2 + 2pq + q^2 = 1$$

Give your answer to **two** decimal places.

(3)

Answer

(Total for question = 9 marks)

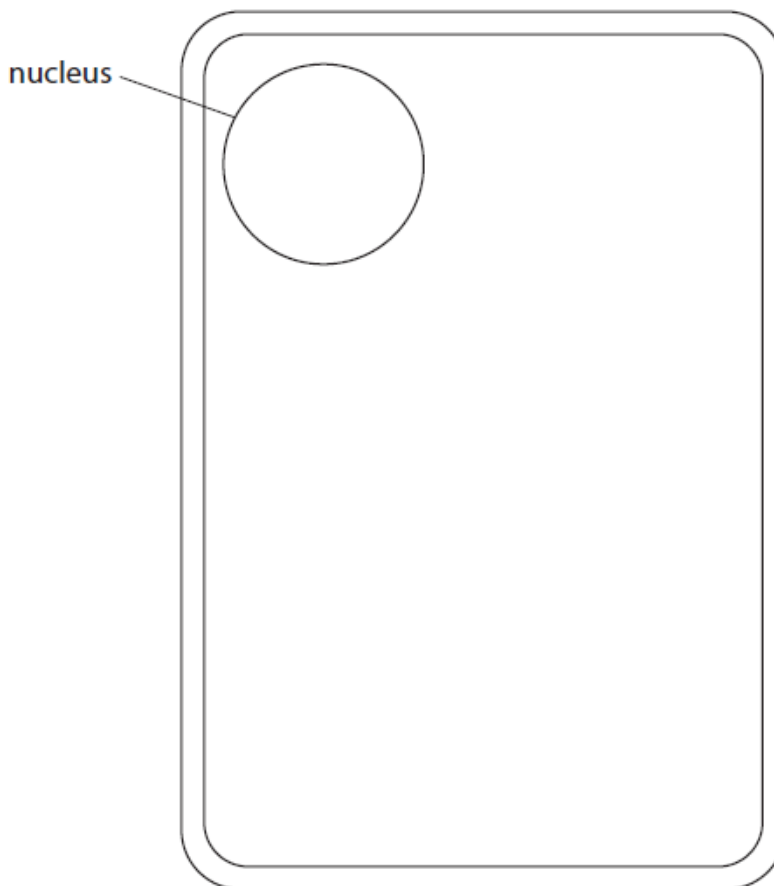
Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Woese classified organisms into a three-domain system.

Plant cells were classified into the Eukarya domain.

The diagram shows an incomplete cell from a plant.

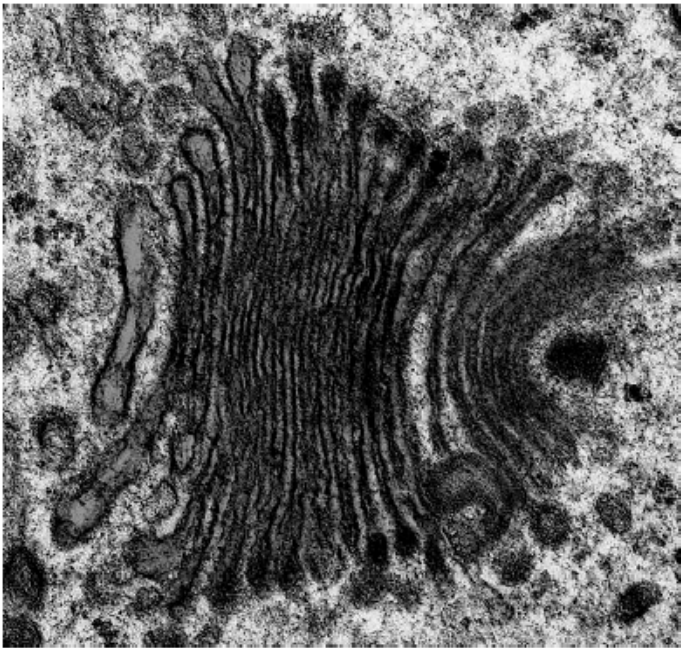


(a) Complete the diagram by drawing an amyloplast, a chloroplast and the tonoplast to show their location and relative size in this cell.

Label these three structures.

(3)

(b) The photograph shows an organelle found in a plant cell, as seen using an electron microscope.



(Source: © SCIENCE PHOTO LIBRARY)

State the function of this organelle.

(1)

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(c) The other domains in the three-domain system are Archaea and Bacteria. Complete the table to show in which of the domains the following structures would be found.

(4)

Structure	Archaea only	Bacteria only	Eukarya only	More than one domain
cell membrane	☐	☐	☒	☒
nucleolus	☐	☐	☒	☒
cell wall	☐	☐	☒	☒
70S (small) ribosome	☐	☐	☒	☒

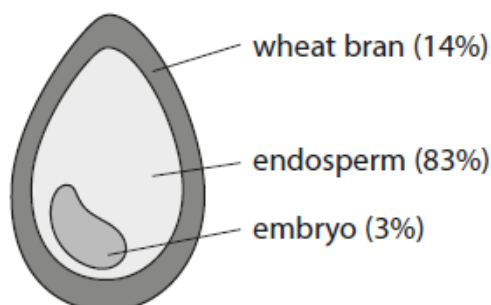
(Total for question = 8 marks)

Q4.

Plant-based products can replace plastics produced from oil.

Wheat bran comes from the outer layers of grains of wheat.

(a) The diagram shows the structure and composition of a grain of wheat.



Wheat bran contains 43% fibre.

A grain of wheat has a mass of 48 mg.

Calculate the mass of fibre in the wheat bran of this grain of wheat.

Give your answer to **two** significant figures.

(3)

Answer mg

(b) Disposable plates and cutlery can be made from either plant-based products or from oil-based plastics.

The photograph shows cutlery and a plate made from wheat bran.



(Source: © Konektus Photo/Shutterstock)

Explain the advantages of using cutlery and plates made from wheat bran instead of oil-based plastics.

(3)

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(c) The endosperm of a grain of wheat develops from the endosperm nucleus, formed during fertilisation.

Explain the role of the pollen tube and nuclei in the formation of the endosperm nucleus.

(3)

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(Total for question = 9 marks)

Q5.

Abaca plants are found in the Philippines.

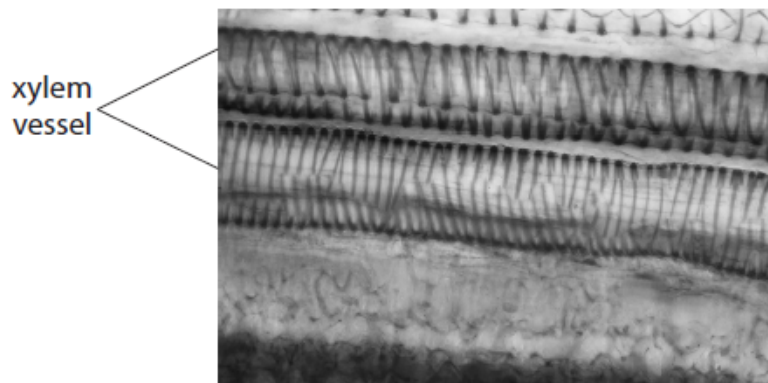
The photograph shows a mat made from abaca plant fibres.



(Source: © Mehmet Çetin / Alamy Stock Photo)

Plant fibres include xylem vessels.

(a) The photograph shows some xylem vessels, as seen using a light microscope.



(Source: © STEVE GSCHMEISSNER / SCIENCE PHOTO LIBRARY)

A stain was added to the xylem before viewing using a microscope.

Give a reason why it is usual to stain specimens in microscopy.

(1)

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(b) Explain how the arrangement of cellulose molecules and secondary thickening in xylem vessels contributes to the physical properties of the cell wall.

(4)

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(Total for question = 5 marks)

Q6.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

Some of the characteristics of an organism are due to polygenic inheritance.

(a) Every person has a Rhesus characteristic.

People who are Rhesus positive have one or more of three types of Rhesus antigen C, D or E, on the cell surface membrane of their red blood cells.

Each Rhesus antigen is coded by a dominant allele of gene C or gene D or gene E.

People who are Rhesus negative for one of these genes will have two recessive alleles.

For example, a person who is Rhesus D negative will have inherited two recessive d alleles.

The diagram shows the loci of these three genes on a pair of chromosomes.



(i) State what is meant by the term **allele**.

(1)

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(ii) Which of the following is the genotype of a person who is Rhesus negative for all three genes?

(1)

- ☐ **A** ccddee
- ☐ **B** ccddEe
- ☐ **C** CcDdEe
- ☐ **D** CCDDEE

(iii) Rhesus antigens are glycoproteins.

Describe how a Rhesus antigen would be produced from its polypeptide chain and transported to the cell surface membrane.

(5)

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(b) Seed colour in wheat is an example of polygenic inheritance. There are three genes thought to affect seed colour (A, B, C). Each gene has a dominant and recessive allele.

A cross between two heterozygous plants (AaBbCc) was carried out.

The seed colour of the offspring was recorded.

The table below shows the phenotype of the wheat seed colour, the number of recessive alleles and the frequency of seed colour in the offspring.

Colour of wheat seed	Number of recessive alleles	Frequency of seed colour
White	6	1
Very light red	5	6
Light red	4	15
Intermediate red	3	20
Red	2	15
Moderate red	1	6
Dark red	0	1

Explain this variation in the colour of wheat seeds.

(3)

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(Total for question = 10 marks)

Q7.

Some of the characteristics of an organism are due to polygenic inheritance.

(a) The photograph shows some Chinese white kidney beans.



The mass of individual Chinese white kidney beans varies. This is partly due to polygenic inheritance.

(i) State what is meant by the term **polygenic inheritance**.

(2)

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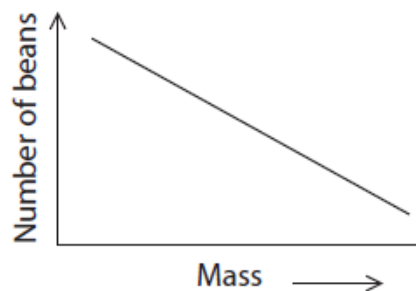
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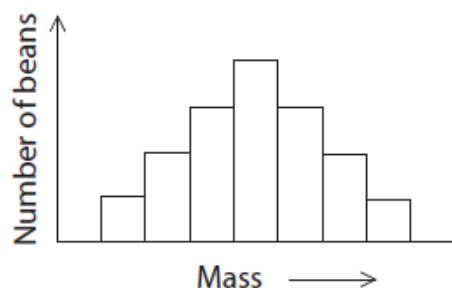
(ii) Which of the following graphs represents the distribution of mass of these beans?

(1)

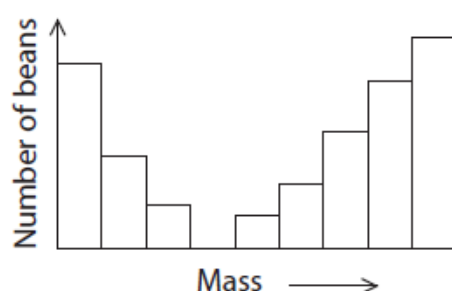
☐ A



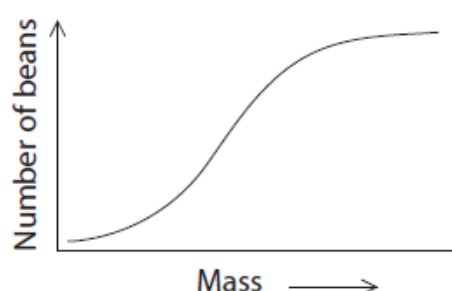
☐ B



☐ C



☐ D



(b) The inheritance of height is another example of polygenic inheritance.

It is possible to predict how tall children could become when they reach adulthood.

The prediction uses the following steps.

1. Add the mother's height (cm) to the father's height (cm).
2. Add 13 cm if the child is a boy or subtract 13 cm if the child is a girl.
3. Divide by two.

(i) A woman with a height of 1.59 m has a daughter. The father is 1.76 m tall.

Calculate the predicted adult height of their daughter.

(1)

Answer m

(ii) Explain why their daughter may not grow to be this height.

(3)

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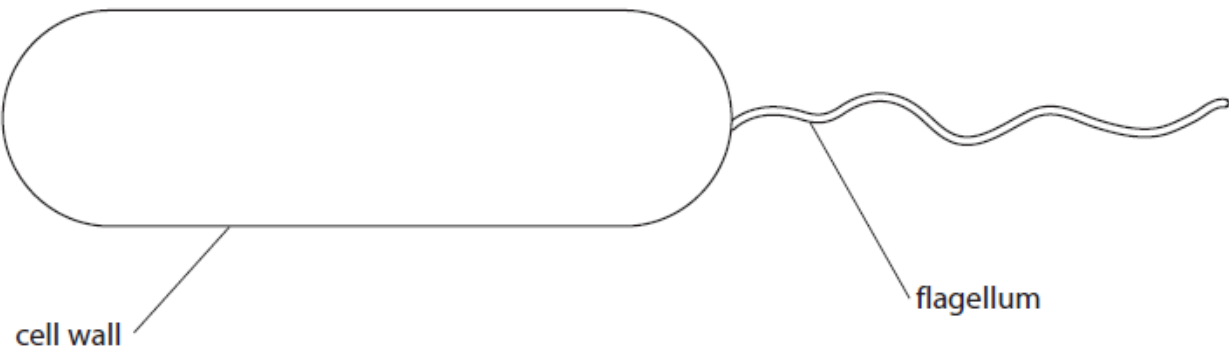
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(Total for question = 7 marks)

Q8.

The diagram shows part of a prokaryotic cell, as drawn by a student.



(a) Draw **and** label a capsule and two pili on the diagram.

(2)

(b) The effect of concentrations of sodium chloride solution on the growth of bacteria was investigated.

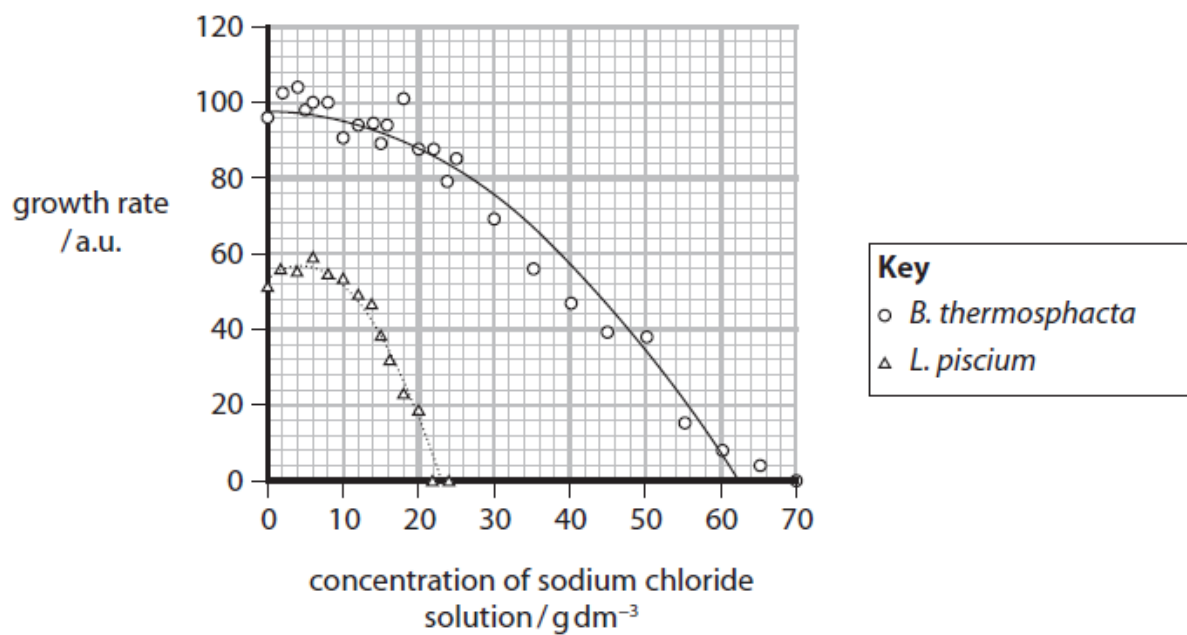
The same number of *L. piscium* bacteria were added to test tubes containing different concentrations of sodium chloride solution.

The volume of sodium chloride solution was the same in each test tube.

The growth rates of the bacteria were recorded after a set period of time.

The investigation was repeated with *B. thermosphacta* bacteria.

The graph shows the results of this investigation.



Comment on the results of this investigation.

(4)

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(Total for question = 6 marks)

Q9.

Answer the questions with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Woese classified organisms into a system with three domains.

(a) How many of the domains contain prokaryotic organisms?

(1)

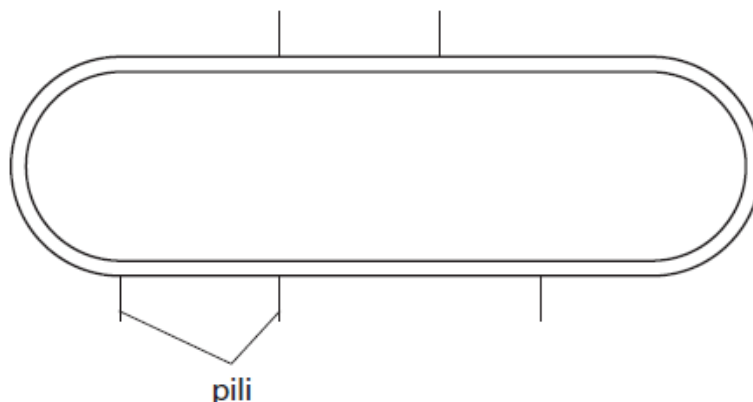
☐ **A** none

☐ **B** one

☐ **C** two

☐ **D** three

(b) The diagram shows part of a prokaryotic cell, as drawn by a student.



(i) Complete the diagram by drawing and labelling a flagellum and a plasmid.

(2)

(ii) State the function of a plasmid.

(1)

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(c) (i) The ribosomes in prokaryotic cells are different from the ribosomes in eukaryotic cells.

Give **one** difference between prokaryotic ribosomes and eukaryotic ribosomes.

(1)

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(ii) How many of the following statements about eukaryotic ribosomes are correct?

- ribosomes are located on the surface of both types of endoplasmic reticulum
- ribosomes are located inside chloroplasts and mitochondria
- ribosomes are involved in the process of transcription

(1)

- ☐ **A** none
- ☐ **B** one
- ☐ **C** two
- ☐ **D** three

(Total for question = 6 marks)

Q10.

Skin colour is an example of continuous variation in some species.

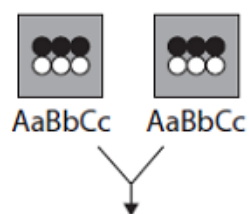
In one species skin colour is polygenic and controlled by three genes: A, B, and C.

Two individuals heterozygous for each of these three genes were crossed.

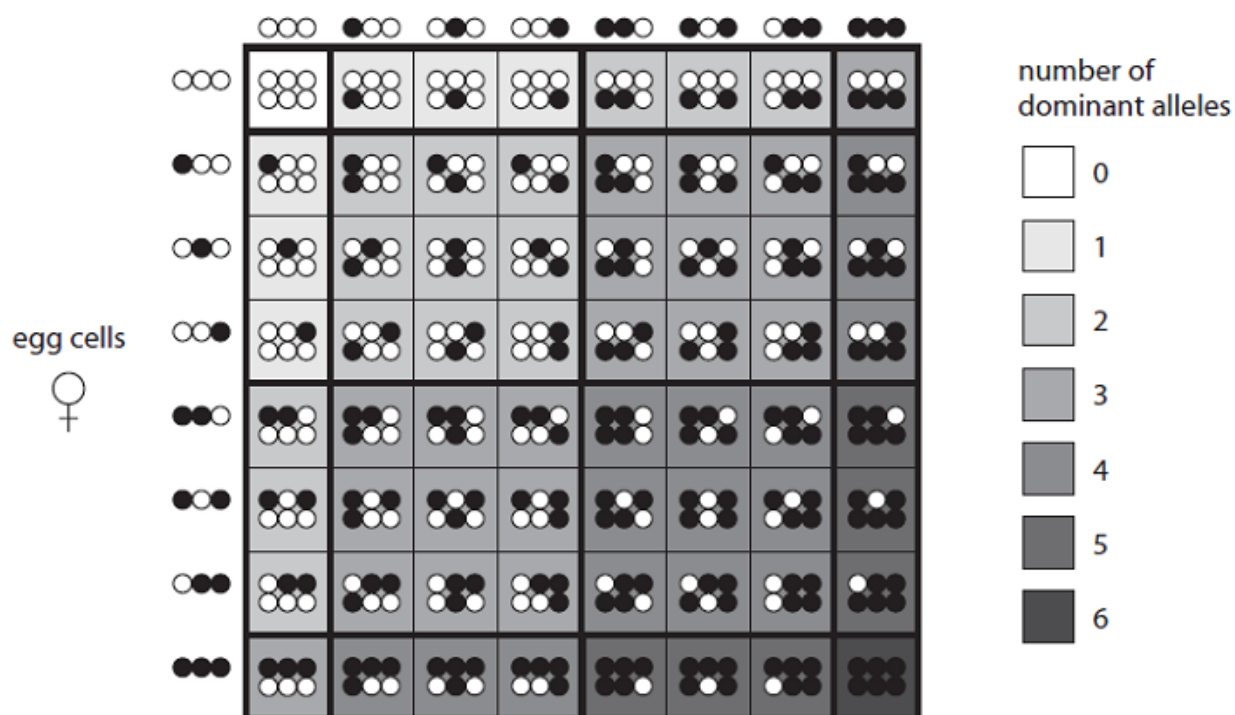
The diagram shows the possible allele combinations present in the gametes and the offspring produced in this cross.

The shading indicates the darkness of the skin colour of the offspring.

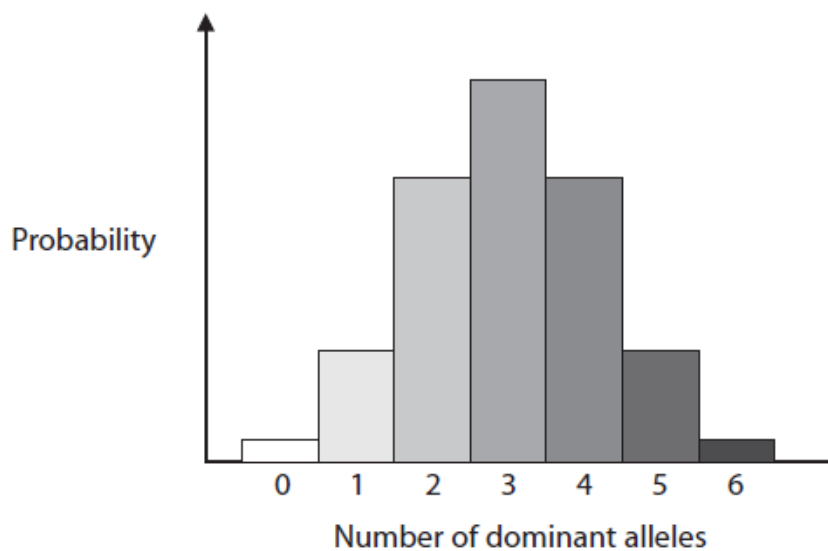
● = dominant allele present
○ = recessive allele present



sperm cells ♂



The graph shows the probability of the skin colours of the offspring from this cross.



*(a) Explain why there is a large variation in the skin colour of the offspring produced from this cross.

Use information from the question, and your own knowledge, to help support your answer.

(6)

(b) Suggest **two** reasons why individuals that have inherited the genotype AaBbCc, may have a darker skin colour than other individuals with the same genotype.

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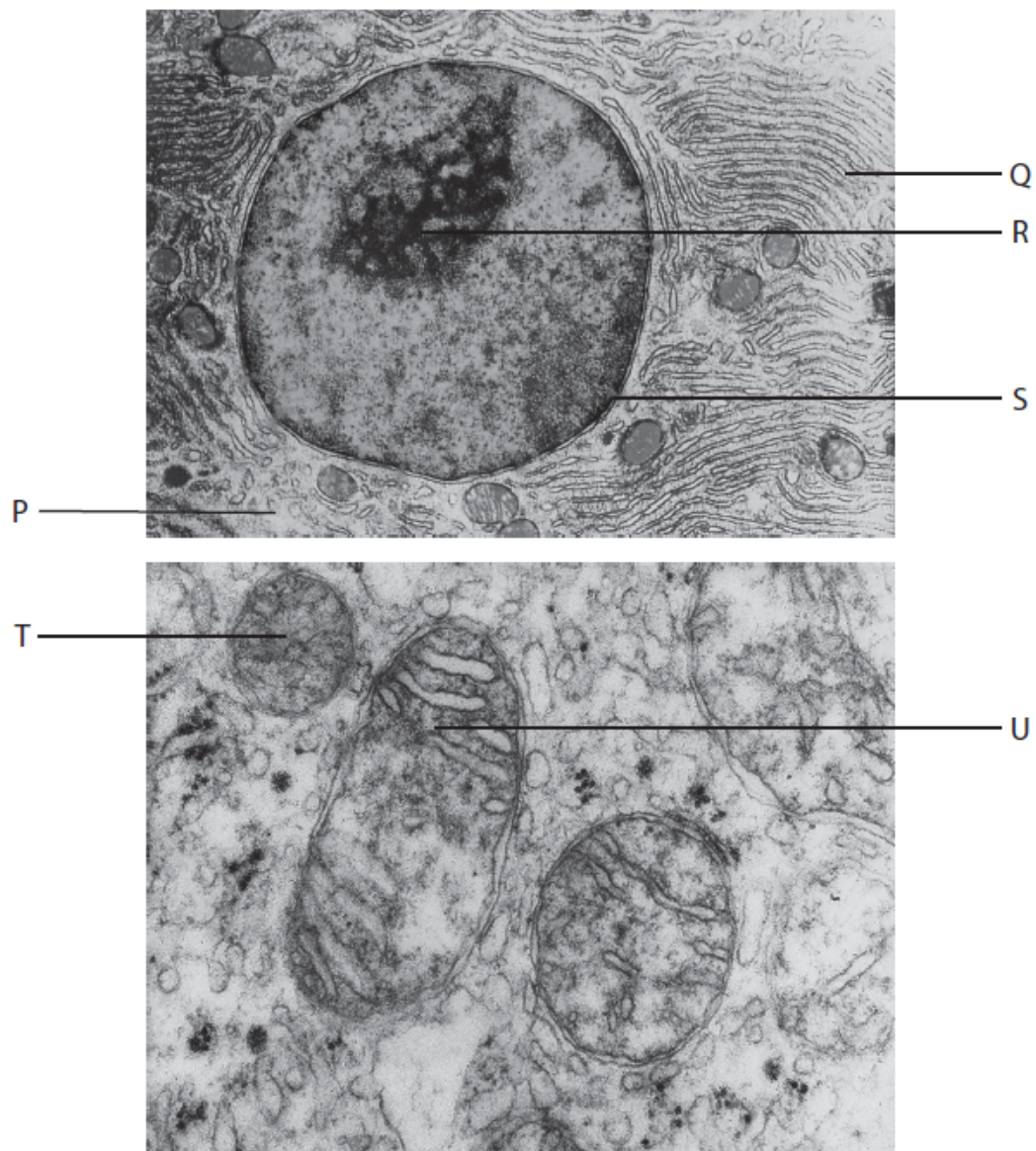
(Total for question = 8 marks)

Q11.

Insulin is a protein produced in beta cells in the pancreas.

Ribosomes are involved in the production of insulin.

(a) The photographs show part of a beta cell from the pancreas, as seen using an electron microscope.



(Source: © Don Fawcett/Science Photo Library
© Martin M. Rotker/Science Photo Library)

(i) Which labelled structure produces ribosomes?

(1)

☒ **A** P

☐ **B** Q

☐ **C** R

☐ **D** S

(ii) The structures labelled T and U are the same type of organelle.

Suggest why these structures look different in this photograph.

(2)

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(iii) A student measured the length of the structure labelled U as 52 mm.

The actual length of this structure is 3.0 μm .

Calculate the magnification of this electron microscope image.

(2)

Answer

(b) Describe how the protein insulin is transported from the ribosomes and then secreted by a beta cell.

(5)

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(c) Explain why beta cells can produce insulin but other cells in the pancreas do not.

(5)

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(Total for question = 15 marks)

The common wombat is endemic to Australia and Tasmania.

The photograph shows a common wombat.



(Source: © Albert Ziraj / Alamy Stock Photo)

magnification $\times 0.1$

(a) Common wombats mark areas of their habitat to signal to other wombats of the same species that they are living there. These marked areas are called territories.

Common wombats produce cube-shaped faeces. It is thought that these cubes can be stacked to mark territory without rolling away.

(i) Calculate the surface area : volume ratio of one cube with a length of 2.5 cm.

(2)

Answer

(ii) State what is meant by the term **habitat**.

(1)

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(iii) State what is meant by the term **species**.

(1)

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(b) The height of a wombat is a result of polygenic inheritance.

State what is meant by the term **polygenic inheritance** with reference to wombat height.

(1)

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(c) Common wombats dig burrows to live in. They have adaptations to help them to do this successfully.

Describe **two** anatomical adaptations of a common wombat that help it to dig burrows to live in.

Use the information in the photograph to support your answer.

(2)

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(Total for question = 7 marks)

Q13.

Egg cells vary in size.

(a) The table shows the size of egg cells from three species of animal.

Species	Diameter of egg cell / μm
Orb weaver spider	10
Human	150
Blue poison dart frog	1600

(i) Which of the following shows the diameter, in standard form, of the egg cell of a blue poison dart frog?

(1)

- ☐ **A** $1.6 \times 10^{-2} \mu\text{m}$
- ☐ **B** $1.6 \times 10^2 \mu\text{m}$
- ☐ **C** $1.6 \times 10^{-3} \mu\text{m}$
- ☐ **D** $1.6 \times 10^3 \mu\text{m}$

(ii) The egg cells of humans and blue poison dart frogs are approximately spherical.

The volume of a sphere (V) is calculated using the formula

$$V = \frac{4}{3}\pi r^3$$

The volume of the human egg cell is $1.8 \times 10^6 \mu\text{m}^3$.

Calculate how many times larger the volume of the blue poison dart frog egg cell is than the volume of a human egg cell.

Give your answer to two significant figures.

(3)

Answer

(b) An egg cell and a skin cell were removed from a female human.

Both cells contained a nucleus.

The skin cell contained 46 chromosomes.

Explain the differences between the genetic material from these two cells.

(4)

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(Total for question = 8 marks)

Q14.

Red blood cells are produced from pluripotent stem cells found in bone marrow.

(a) Which statement about these stem cells is correct?

(1)

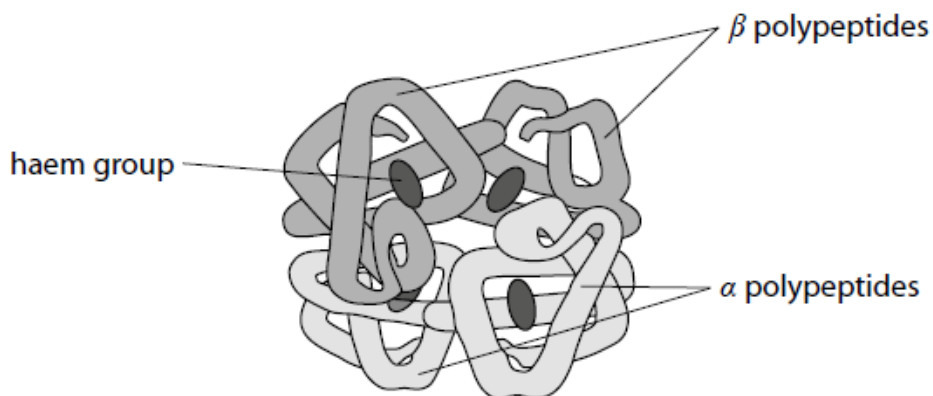
- ☐ **A** they can produce all types of cell
- ☐ **B** they can produce all types of cell except extraembryonic cells
- ☐ **C** they can produce some types of cell
- ☐ **D** they can produce red blood cells only

(b) Red blood cells contain haemoglobin.

A molecule of haemoglobin is made of four polypeptides. Each polypeptide has a haem group attached to it. The haem group is **not** made of amino acids.

In most adult haemoglobin, there are two α polypeptides and two β polypeptides.

The diagram shows the structure of adult haemoglobin.



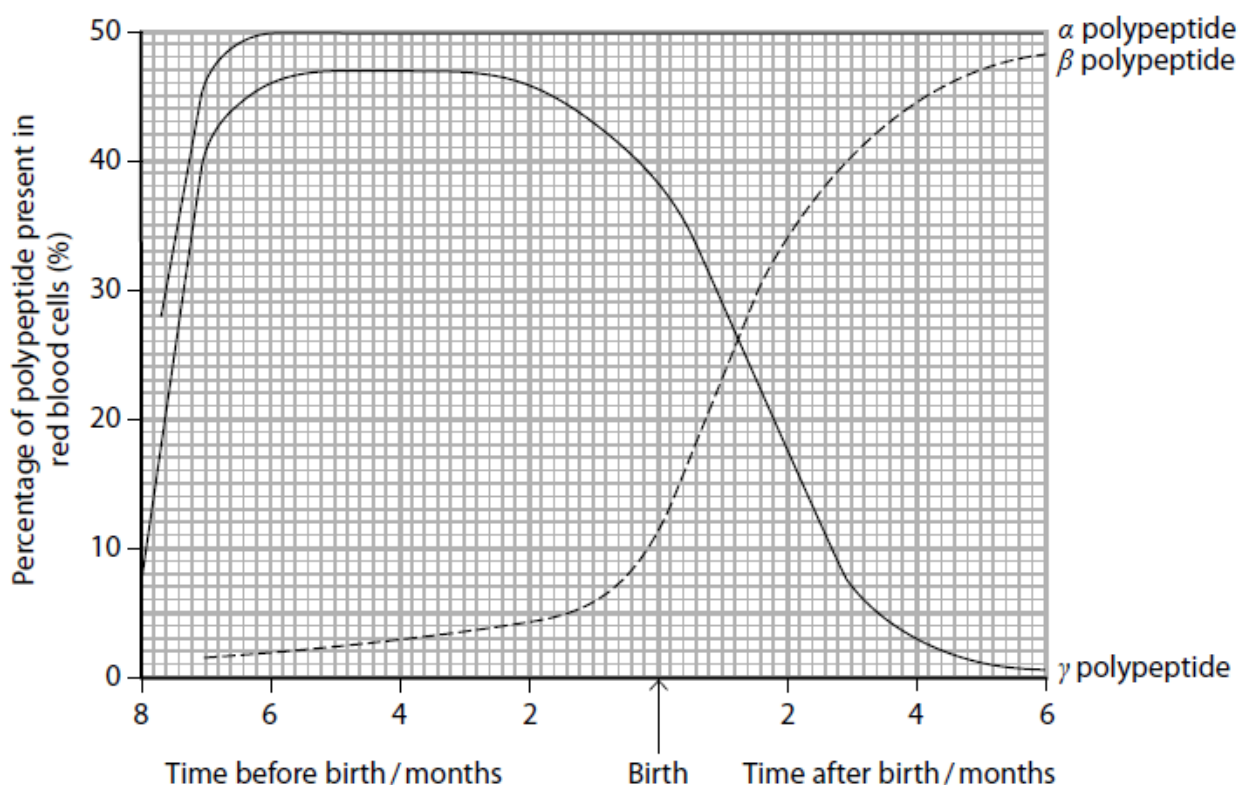
Describe the role of the rough endoplasmic reticulum in the synthesis of haemoglobin.

(3)

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(c) Fetal haemoglobin has a similar structure to adult haemoglobin. Fetal haemoglobin has two α polypeptides and two γ polypeptides.

The graph shows the percentage of each polypeptide present in red blood cells in an individual before and after birth.



(i) Describe the changes in the percentages of polypeptides present in red blood cells. Use the information in the graph to support your answer.

(3)

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(ii) Explain how epigenetic modification could result in these changes.

(4)

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(Total for question = 11 marks)

Q15.

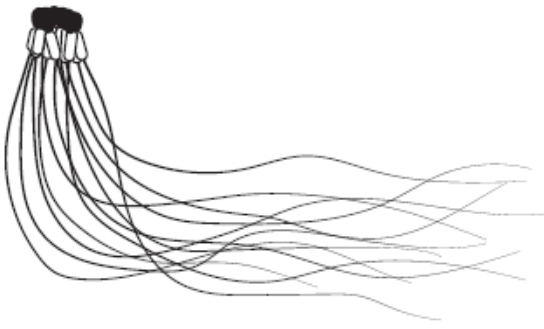
Gametes are specialised for their function.

Egyptian female desert ants (*Cataglyphis savignyi*) mate with more than one male.

A male desert ant has an adaptation to improve the chances of his sperm fertilising a female's egg cell.

The sperm are released in bundles with the heads held together by a sticky protein.

The diagram shows a bundle of desert ant sperm.



(a) Suggest how the sticky proteins would have been secreted.

(2)

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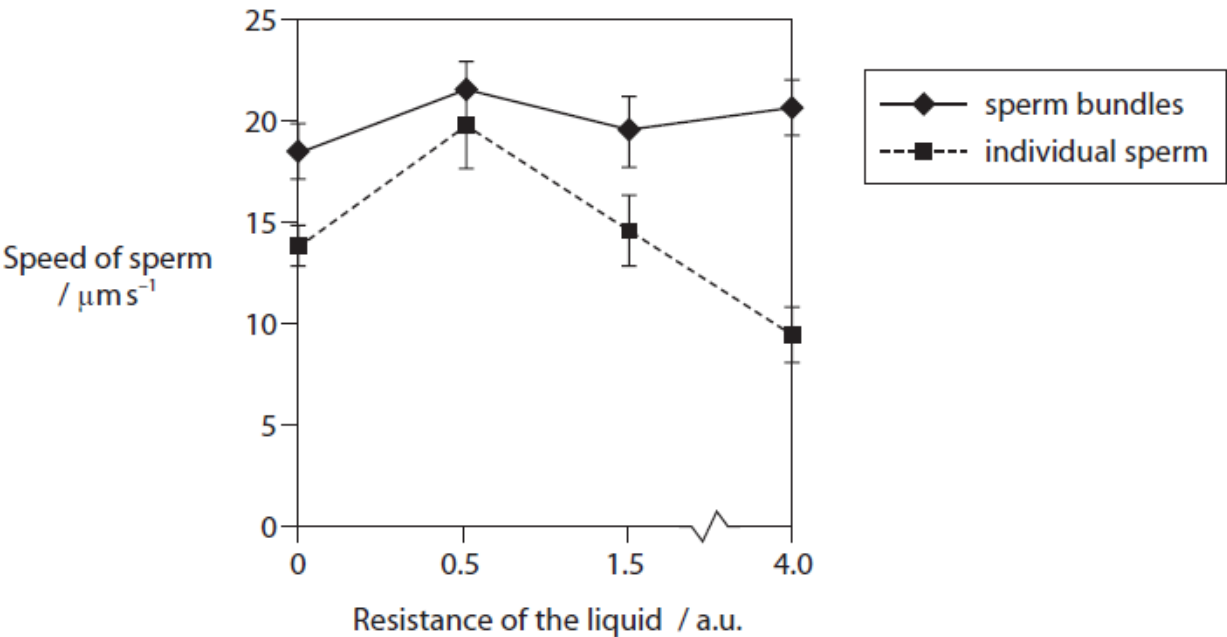
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(b) The graph shows the speed of individual sperm compared with bundles of sperm in liquids of different resistance.



Comment on the results of this investigation.

(4)

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(c) The photograph shows an Amur leopard found in southeastern Russia and northern China.

In-vitro fertilisation (IVF) techniques are being developed to help conserve this endangered species of leopard.



(Source: © NaturalLight / Alamy Stock Photo)

These techniques are being developed using mice.

IVF involves the removal of egg cells from the female mice. The zona pellucida can be damaged during this process.

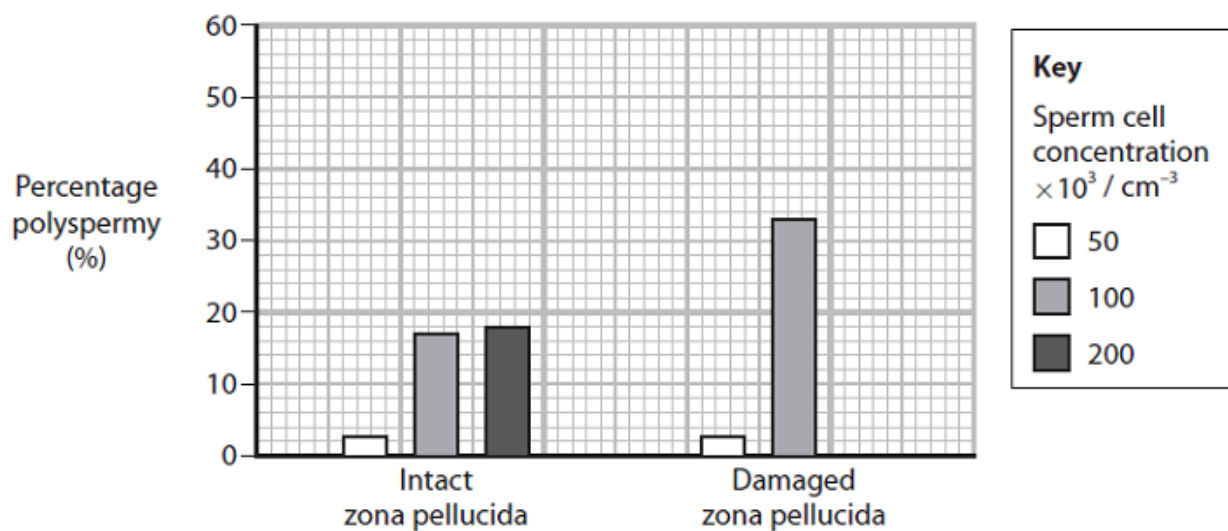
The effect of damaging the zona pellucida was investigated.

Three hundred mouse egg cells were distributed equally in three Petri dishes containing nutrient solutions.

Samples of sperm of different concentrations were added to each Petri dish. The volume of each sample added was the same.

The experiment was repeated for egg cells which had their zona pellucida damaged.

The graph shows the percentage of egg cells fertilised by more than one sperm (percentage polyspermy).



(i) When the highest sperm concentration was added to the egg cells with damaged zona pellucida, the percentage polyspermy was 52%.

Plot this result on the graph.

(1)

(ii) Explain the results of this investigation.

(4)

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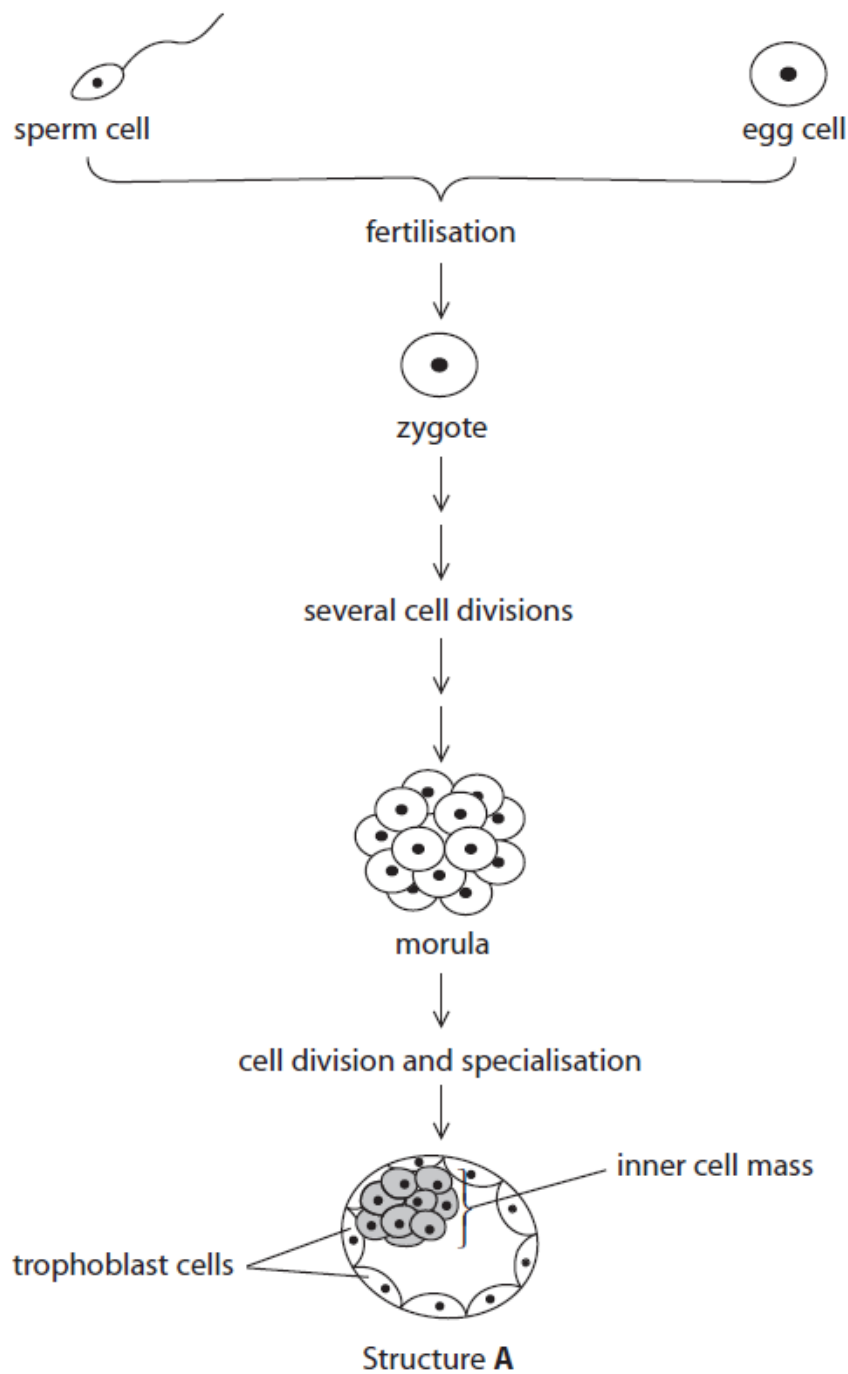
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(Total for question = 11 marks)

Q16.

The diagram shows three structures that form after the fertilisation of an egg cell.



(a) Explain why the cells in the morula are genetically identical.

(2)

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(b) Structure **A** can be used as a source of pluripotent stem cells.

(i) Name structure **A**.

(1)

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(ii) Stem cells can be used as a medical treatment when a patient has had a severe heart attack.

A severe heart attack can cause the death of heart muscle cells.

The medical treatment involves injecting stem cells into damaged areas of the heart muscle.

Suggest why injecting pluripotent stem cells may benefit a person who has had a severe heart attack.

(2)

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(Total for question = 5 marks)

Q17.

Sweet pea plants were originally found in Sicily and southern Italy.

They are used to investigate genetic inheritance and linkage.

The photograph shows a flowering sweet pea plant.



(Source: © Tim Gainey/Alamy Stock Photo)

Sweet pea plant flowers can be different colours and have a variety of pollen grain shapes.

(a) (i) How many of the following statements about a pollen grain are correct?

- contains a tube nucleus and a generative nucleus
- the generative nucleus divides by mitosis to form two female gametes
- can produce diploid gametes

(1)

- ☐ **A** none
- ☐ **B** one
- ☐ **C** two
- ☐ **D** three

(ii) The table gives information about the surface area and volume of round and long pollen grains.

Pollen grain shape	Surface area	Volume / μm^3	Surface area to volume ratio
round	5.03	33.5	0.150
long		25.8	0.160

Calculate the difference in surface area between round and long pollen grains.

Give your answer in standard form with appropriate units.

(2)

Answer

(b) Plants that grow from a sweet pea seed contain stem cells.

Describe how a stem cell in a plant can become a sclerenchyma cell.

(4)

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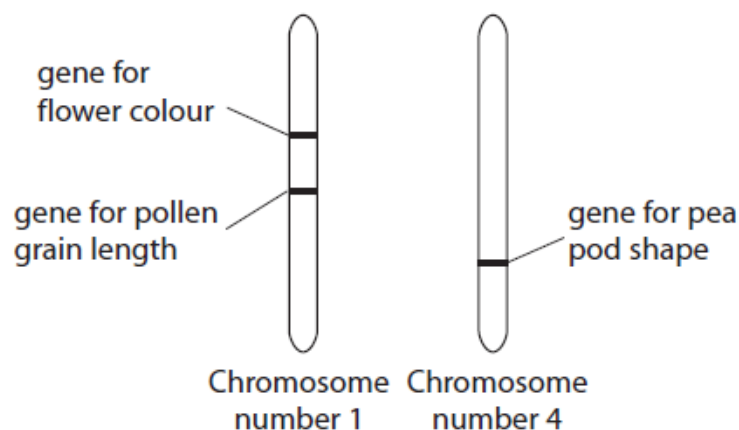
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(c) Sweet pea plants were used in an investigation into the inheritance of flower colour, pollen grain length and pea pod shape.

Each of these traits is controlled by a single gene. Sweet peas have seven pairs of chromosomes.

The arrangement of these three genes on sweet pea chromosomes is shown in the diagram.



Comment on the role of meiosis in the inheritance of these traits.

(4)

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(Total for question = 11 marks)

Q18.

Tendrils are produced by climbing plants, such as pea plants.

The photograph shows the tendrils on a growing pea shoot.



(Source: © Jerry Lin/Shutterstock)

A tendril is a modified leaf that can coil around anything it touches.

Cells in the tip of the tendril divide by mitosis.

(a) A student investigated the mitotic index of cells in the tips of tendrils.

Acetic orcein stain was added to the tissues from the tips of the tendrils.

(i) Give **one** reason why the cells were stained in this investigation.

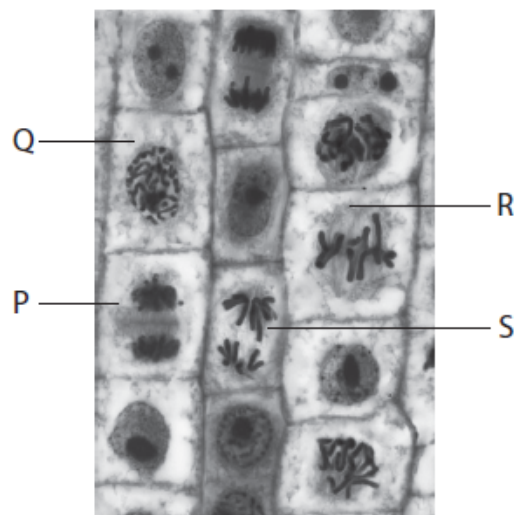
(1)

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(ii) The photograph shows these cells, as seen using a light microscope.



(Source: © Steve Gschmeissner/Science Photo Library)

Which labelled cell is in the metaphase stage of mitosis?

(1)

- ☐ **A** P
- ☐ **B** Q
- ☐ **C** R
- ☐ **D** S

(iii) The table shows the results of this investigation.

Stage	Number of cells
Interphase	117
Prophase	15
Metaphase	3
Anaphase	10
Telophase	5

Calculate the mitotic index.

(2)

Answer

(b) Suggest the advantages of tendrils for the pea plant.

(3)

(c) Pea plants produce flowers.

Some cells in the flowers undergo meiosis.

Explain how the separation of chromosomes in meiosis gives rise to genetic variation in the offspring of pea plants.

(3)

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(Total for question = 10 marks)

Q19.

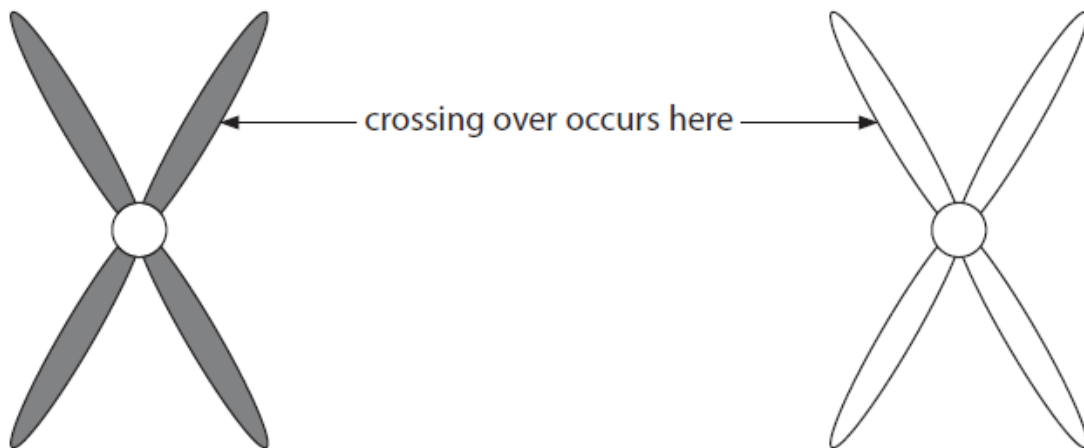
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Meiosis and mitosis are involved in cell division.

(a) Meiosis produces gametes that are genetically different.

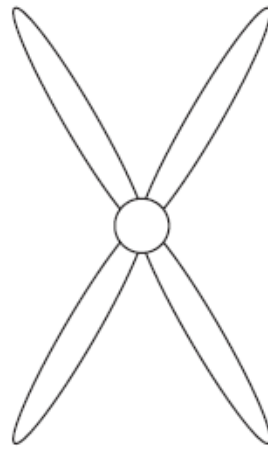
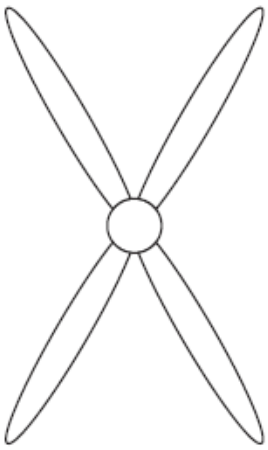
Crossing over is important to increase genetic variation.

The diagram shows one pair of homologous chromosomes during early meiosis.



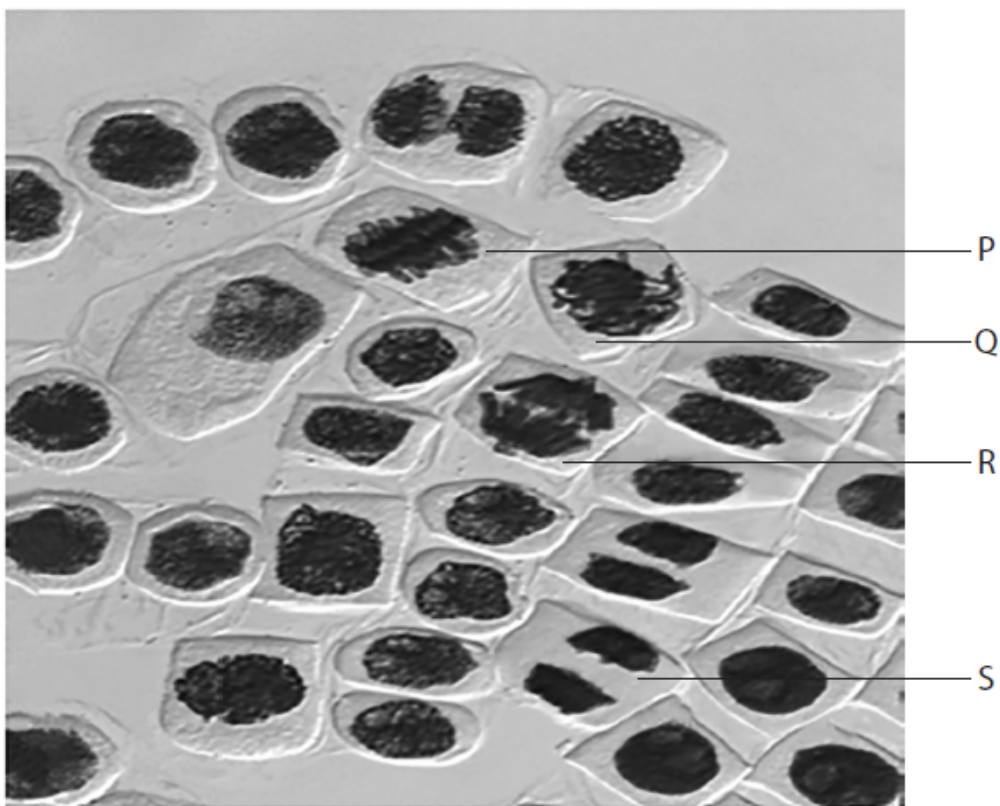
Complete the diagram below to show these chromosomes after crossing over has occurred.

(2)



(b) The photograph shows some cells undergoing mitosis.

Each labelled cell is in a different stage of mitosis.



(i) Which cell is in prophase?

(1)

☐ **A** P

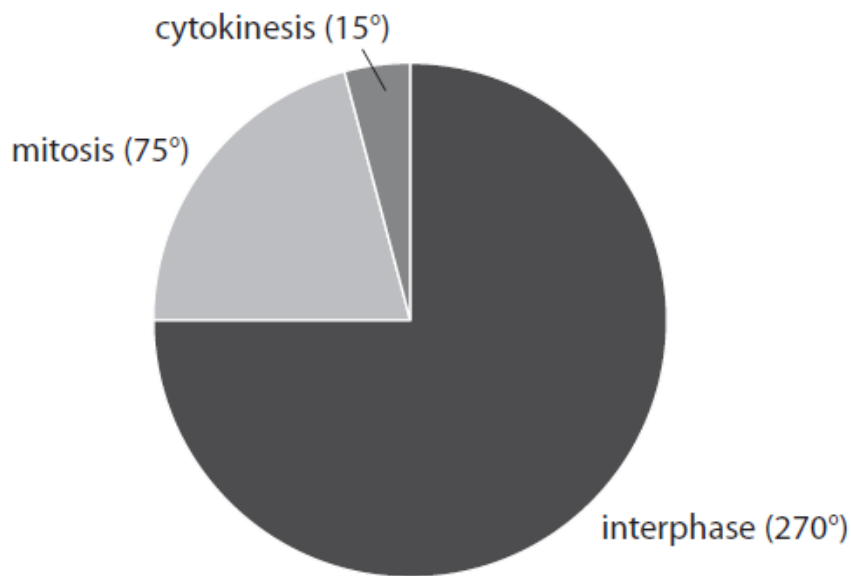
☐ **B** Q

☐ **C** R

☐ **D** S

(ii) In some embryo cells, interphase can last an average of nine hours.

The diagram shows the relative proportions of time spent in each part of the cell cycle.



Calculate how long cytokinesis would take in these embryo cells.

(1)

Answer hours

(iii) Calculate the total number of cells resulting from one cell dividing by mitosis eight times.

(1)

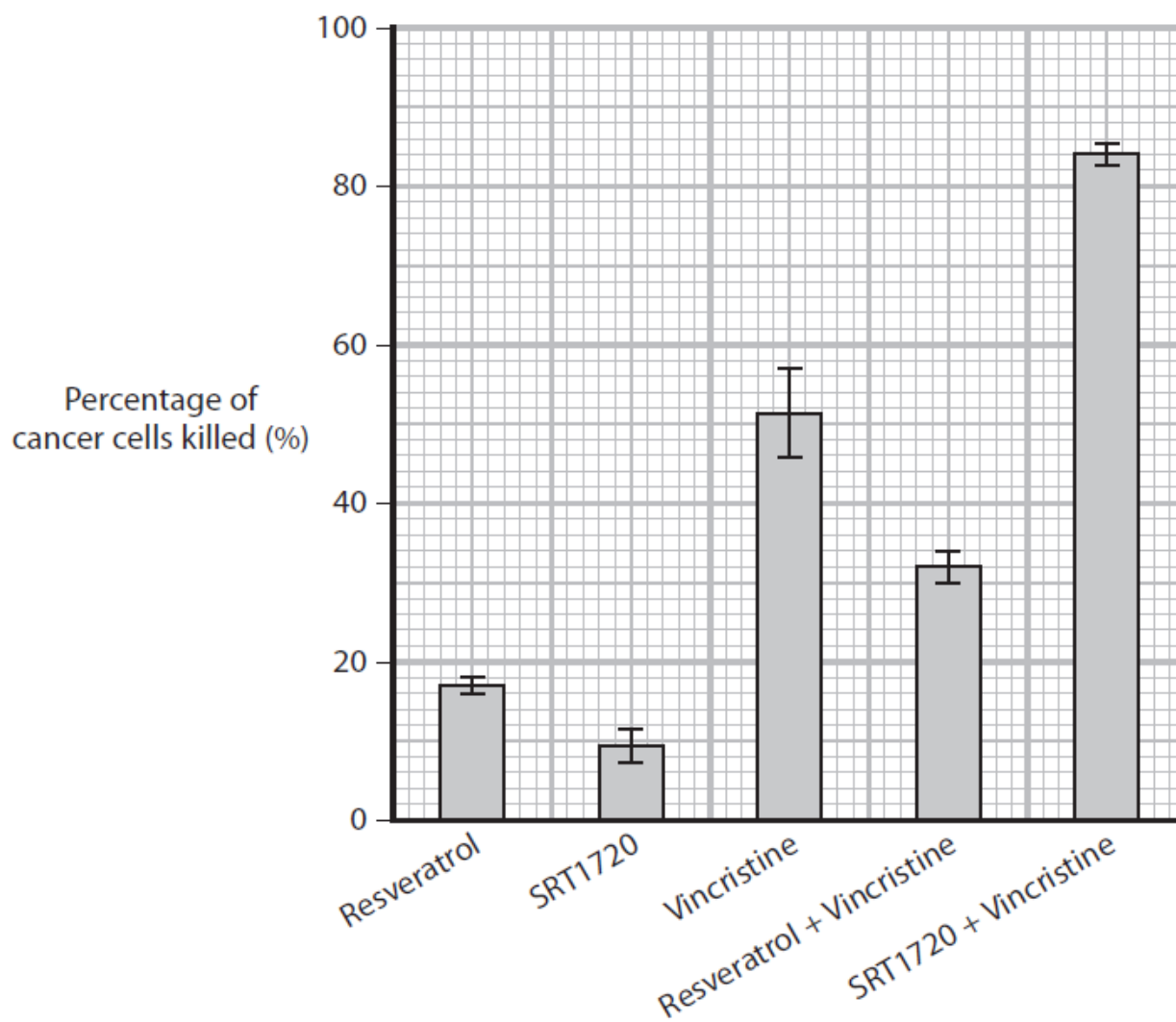
Answer

(c) Ewing's sarcoma is a type of cancer.

Resveratrol, SRT1720 and Vincristine are drugs used to kill cancer cells.

An investigation was carried out to determine the most effective treatment for patients with Ewing's sarcoma.

The graph shows the results of this investigation.



(i) Vincristine prevents spindle fibres from shortening during mitosis.

This leads to the death of the cell.

At which stage of mitosis do the spindle fibres contract?

(1)

- ☐ **A** anaphase
- ☐ **B** metaphase
- ☐ **C** prophase
- ☐ **D** telophase

(ii) Evaluate the effectiveness of the three drugs used in this investigation.

Use the information in the graph to support your answer.

(4)

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(Total for question = 10 marks)

Q20.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

There are more than 100 species of trees and shrubs around the world with the common name of 'ironwood'.

One type of ironwood tree, *Tabebuia avellanedae*, is native to South America.

Chemicals from these trees have antibacterial properties.

(a) (i) State the genus to which this plant belongs.

(1)

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(ii) Which structure in the cells of this plant stores starch?

(1)

- ☐ **A** amyloplast
- ☐ **B** middle lamella
- ☐ **C** plasmodesmata

☐ **D** tonoplast

(b) Plague is a disease caused by *Yersinia pestis* bacteria.

Every year, thousands of people around the world are infected with these bacteria.

These bacteria have a thick slime capsule and many pili.

(i) State the function of each of these structures.

(2)

Slime capsule

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Pili

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*(ii) The ironwood tree has wood containing chemical compounds called

naphthoquinones. These compounds have antibacterial properties.

Scientists are investigating whether these compounds could be used to develop a drug to treat people infected with *Y. pestis*.

Describe the methods that would be used to trial a drug containing these compounds.

(6)

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(Total for question = 10 marks)

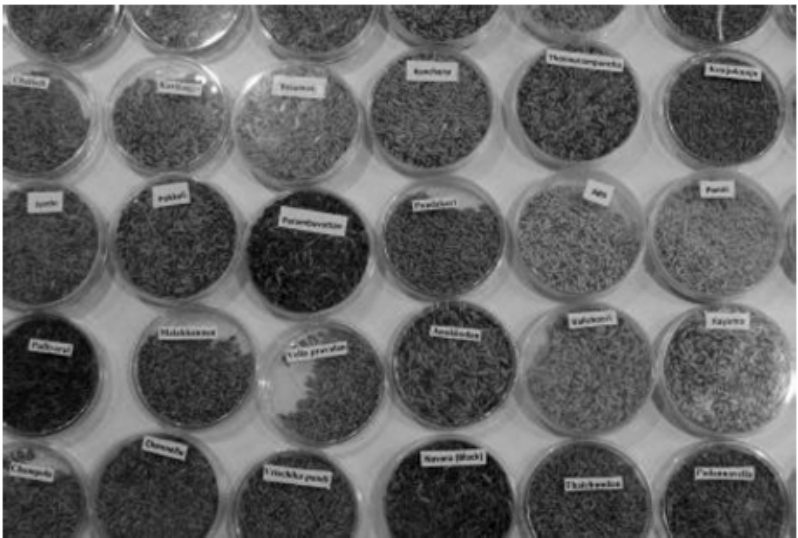
Q21.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

One of the aims of seed banks is to maintain genetic diversity.

Seeds are stored in the Navdanya Seed Vault, one of over a hundred seed banks in India. This seed bank stores over 4000 varieties of rice.

The photograph shows some of these varieties of rice.



(a) (i) Which of the following can be used to calculate genetic diversity?

(1)

☐ **A** Hardy-Weinberg equation

☐ **B** heterozygosity index

☐ **C** index of diversity

☐ **D** mitotic index

(ii) Give **two** differences between genetic diversity and species richness.

(2)

1

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2

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(b) Suggest **two** reasons why seed banks store seeds instead of growing whole plants.

(2)

1

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2

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(c) Bananas are a popular food and seed banks are involved in the development of disease-resistant varieties.

The table shows the mass of bananas imported by three countries in 2007 and in 2011.

Country	Mass imported in 2007 / tonnes $\times 10^5$	Mass imported in 2011 / tonnes $\times 10^5$
China	3.3	8.2
Iran	6.3	6.2
Japan	9.8	1.1

(i) Calculate the percentage increase in the mass of bananas imported by China.

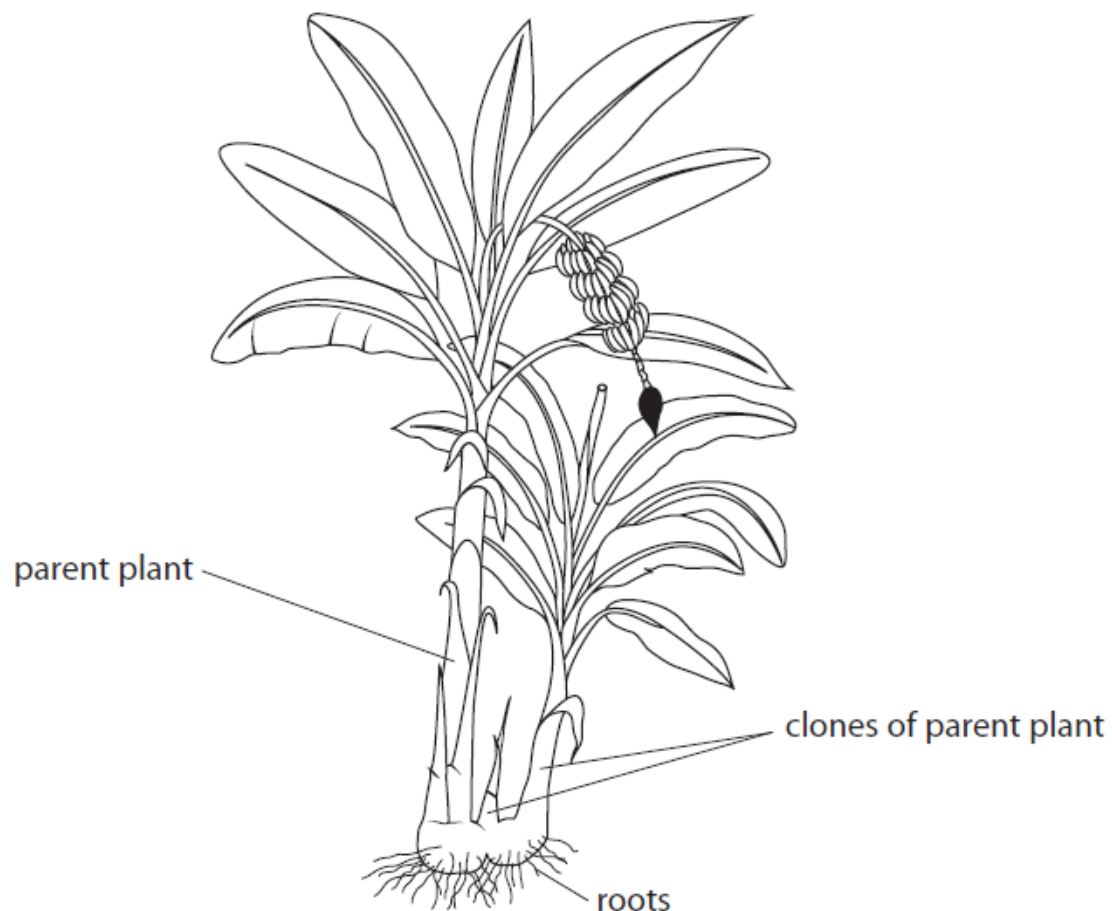
(2)

Answer %

(ii) Banana plants can reproduce asexually.

Most of the bananas grown by farmers around the world are clones from a single parent banana plant called 'The Cavendish'.

The diagram shows a parent banana plant and two clones of this parent plant.



These clones can be removed from the parent plant and grown into new banana plants.

Panama disease is caused by a fungus. It has destroyed Cavendish banana plants in the Philippines. Cavendish banana plants are not resistant to this fungus.

Seed banks around the world have seeds from different varieties of banana.

Scientists are trying to improve the Cavendish banana by breeding it with different varieties of banana.

Explain why scientists are breeding the Cavendish banana with different varieties of banana.

(4)

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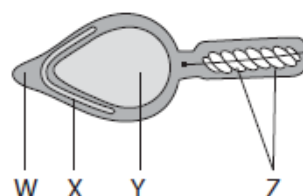
(Total for question = 11 marks)

Q22.

The phenotype of a rabbit is affected by its genotype.

Rabbit sperm cells contain genetic information that will become part of the genotype of the offspring.

The diagram shows part of a rabbit sperm cell.



(a) Which labelled structure contains the genetic information used in the synthesis of acrosomal enzymes?

(1)

☐ **A** W

☐ **B** X

☐ **C** Y

☐ **D** Z

(b) A fertilised rabbit egg cell will divide by mitosis to form a solid ball of genetically identical cells.

Name this solid ball of cells.

(1)

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(c) The genetically identical cells in a developing rabbit embryo will continue to divide by mitosis.

Some of the cells produced can undergo epigenetic modification as they develop into specialised cells.

(i) Epigenetic modification can alter the activation of certain genes.

Describe **one** form of epigenetic modification that could occur in the rabbit cells.

(2)

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(ii) Explain how cells in the rabbit embryo become specialised after epigenetic modification.

(3)

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* (d) The table shows information about three types of rabbit.

Type of rabbit	Black 	Himalayan 	Albino 
Colour of fur	Solid black all over	White fur with black ears, nose, paws and tail	White all over
Allele combination(s)	CC, Cc ^h , Cc ^a	c ^h c ^h , c ^h c ^a	c ^a c ^a

Enzymes produced by the rabbits control the production of pigments in the fur.

One type of rabbit produces an enzyme that is inactive at the core body temperature of the rabbit.

Discuss how genes and the environment interact to produce the fur colour of these three types of rabbit.

Use the information in the question to support your answer.

(6)

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(Total for question = 13 marks)

Q23.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The pancreas is an organ with many functions.

A student observed some cells of the pancreas using an electron microscope.

The student described one organelle that was seen as

"several curved membrane-bound sacs of decreasing size".

(a) (i) Which organelle was seen?

(1)

- ☐ **A** centriole
- ☐ **B** Golgi apparatus
- ☐ **C** rough endoplasmic reticulum

☒ **D** smooth endoplasmic reticulum

(ii) Explain why this organelle cannot be seen using a light microscope.

(2)

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(iii) Give **two** differences between an organ and a tissue.

(2)

1

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(b) Plant cells can also be studied using an electron microscope.

Name **two** structures present in animal cells that are not present in a plant cell.

(2)

1

2

(c) Cells in the pancreas use amino acids to synthesise polypeptides.

These cells also secrete enzymes and glycoproteins into the small intestine.

Cells from the pancreas, containing amino acids labelled with a fluorescent marker, were used in an investigation. The fluorescent marker looked green when seen with a special microscope.

The percentage of green fluorescence inside and outside the cells was measured at the start and after 60 minutes.

The results of this investigation are shown in the table.

Time / min	Percentage of green fluorescence (%)	
	Inside the cells	Outside the cells
0	100	0
60	38	62

Explain the results of this investigation.

(4)

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(Total for question = 11 marks)

Q24.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Organisms can be classified using the three-domain system.

Molecular evidence is used to place an organism into one of the three domains.

(a) (i) Give **one** example of the molecular evidence used to support the three-domain system.

(1)

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(ii) Describe the role of the scientific community in evaluating the evidence for this system of classification.

(2)

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(b) The table shows some features of living organisms.

Which box in each row shows whether the feature is found in these domains?

(4)

Feature	Archaea only	Archaea and Bacteria only	Archaea and Eukarya only	Archaea and Bacteria and Eukarya
absence of a nuclear envelope	☐	☐	☐	☐
presence of circular DNA	☐	☐	☐	☐
presence of a cell membrane	☐	☐	☐	☐
presence of ribosomes	☐	☐	☐	☐

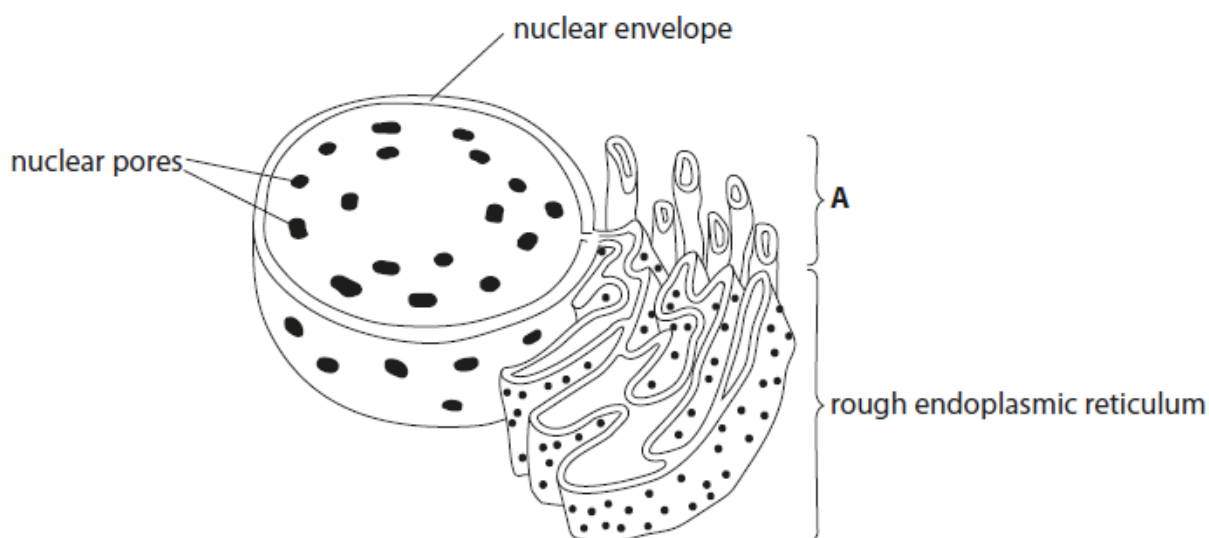
(Total for question = 7 marks)

Q25.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Eukaryotic cells contain cell organelles.

- (a) The diagram shows part of a eukaryotic cell, as drawn by a student.
The nuclear envelope, nuclear pores and rough endoplasmic reticulum are labelled.



- (i) Which of the following is a correct statement about rough endoplasmic reticulum?

(1)

- ☐ **A** it has 70S (small) ribosomes
- ☐ **B** it has 80S (large) ribosomes
- ☐ **C** it forms vesicles surrounding phospholipids only
- ☐ **D** it forms vesicles surrounding polysaccharides only

- (ii) Name a substance synthesised by the organelle labelled **A** in the diagram.

(1)

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- (iii) Name **two** structures that could be present inside the nucleus in the diagram.

(2)

1

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2

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(b) After cell division, the plant cells produced increase in size.
Explain how these plant cells increase in size.

(3)

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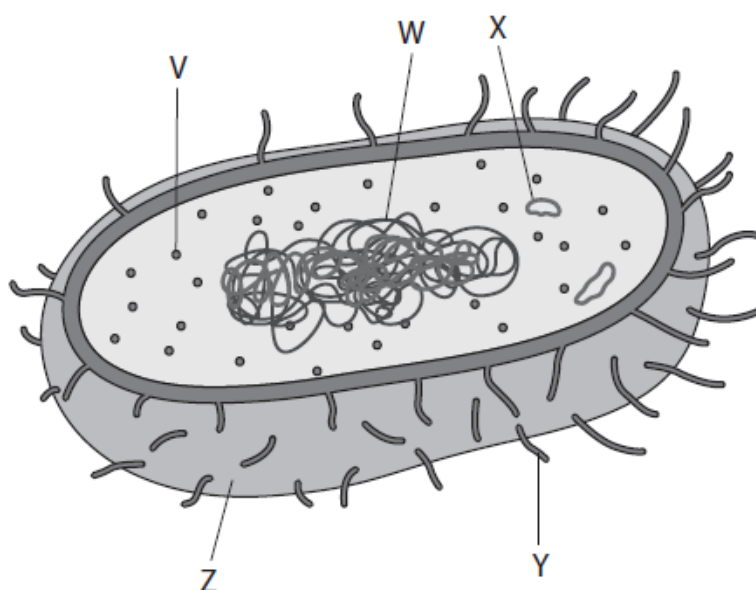
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(Total for question = 7 marks)

Q26.

The diagram shows a prokaryotic cell, drawn by a student.



(a) (i) Which labelled structure is a plasmid?

(1)

☐ **A** W

☐ **B** X

☐ **C** Y

☐ **D** Z

(ii) Which labelled structure enables this cell to adhere to other bacterial cells in conjugation?

(1)

☐ **A** V

☐ **B** X

☐ **C** Y

☐ **D** Z

(iii) State how ribosomes in prokaryotic cells are different from those in eukaryotic cells.

(1)

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(b) Prokaryotic cells may also have a capsule and a flagellum.

State **one** function of each of these structures.

(2)

Capsule

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Flagellum

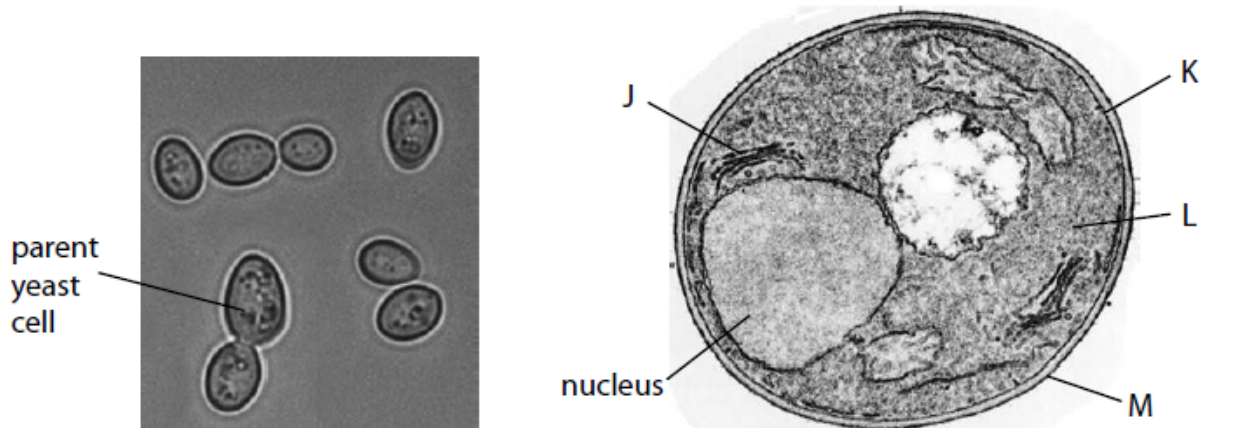
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Q27.

The photographs show yeast cells, seen using a light microscope and an electron microscope.



Yeast cells seen using a light microscope

Yeast cell seen using an electron microscope

Used under CC License from: https://commons.wikimedia.org/wiki/File:Zygosaccharomyces_bailii_cells.jpg

(a) Which structure identifies yeast as a eukaryotic organism?

(1)

- ☐ A J
- ☐ B K
- ☐ C L
- ☐ D M

(b) Explain why structure J can be seen using the electron microscope but not the light microscope.

(2)

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(c) Explain why the nuclear envelope cannot be seen as two membranes using this electron microscope.

(2)

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(d) Yeast cells reproduce asexually by a process called budding.

The parent yeast cell produces a bud.

(i) Explain the importance of mitosis in budding.

(3)

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(ii) Once the bud is large enough, it separates from the parent yeast cell.

The rate at which budding happens depends on the availability of oxygen and nutrients.

Suggest why the availability of oxygen and nutrients determines the rate of budding.

(3)

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(Total for question = 11 marks)

Mark Scheme

Q1.

Question number	Answer	Mark
(a)	{expressed / observable} characteristics	(1)

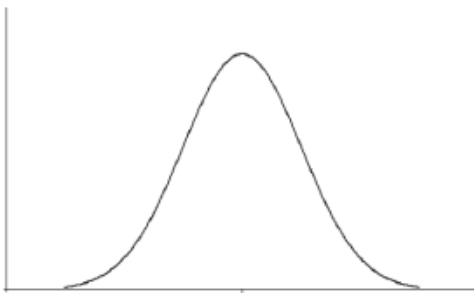
Question number	Answer	Mark
(b)(i)	genotype	(1)

Question number	Answer	Mark
(b)(ii)	B 1, 4	(1)

Question number	Answer	Mark
(c)(i)	B bar chart, histogram	(1)

Question number	Answer	Mark
(c)(ii)	• calculation of one correct difference (1) or • mean height for male and female calculated Example of calculation: $3.2 \div 2.2 = 1.5$ $3.2 \div 2.6 = 1.2$ $4.0 \div 2.2 = 1.8$ $4.0 \div 2.6 = 1.5$ 3.6 and 2.4 • range of difference given 1.2 – 1.8 (1)	(2)

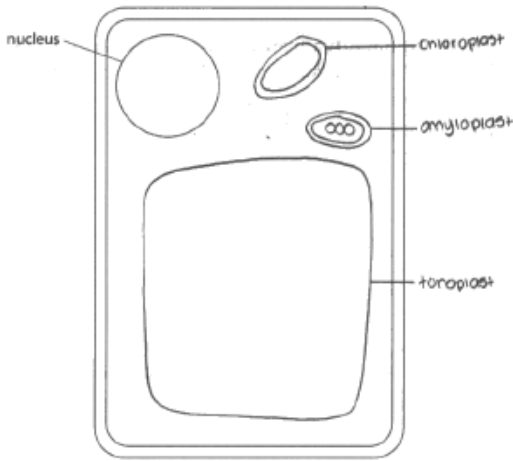
Q2.

Question Number	Answer	Additional guidance	Mark
(a)	• graph showing normal distribution (1) • both axes labelled (1)	Accept peak shifted to left or right Accept suitable labels e.g. phenotype / characteristic / height (cm) on x axis frequency / number of individuals on y axis ignore population <u>Example of graph shape</u> 	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • (because) mutation resulted in these genes {becoming switched on / being expressed / not being switched off / remaining switched on} (1) • {transcription of / (active) mRNA made from} (active tooth production) genes (1) • (therefore) translation (of mRNA) occurs / proteins formed (for teeth development) (1) • (proteins cause) structural change to (beak) cells changes them into teeth cells (1)	Accept differential gene expression Accept proteins result in (embryo) cells differentiating into teeth cells	(4)

Question Number	Answer	Additional guidance	Mark
(c)	A calculation showing the following steps: • calculation of q^2 (1) • value for q (1) • value for p to two decimal places (1)	Mark the answer on answer line first <u>Example of calculation</u> $140 \div 610 = 0.23$ $\sqrt{0.23} = 0.48$ 0.52 Correct answer with no workings scores full marks Allow 52.04% for 3 marks	(3)

Q3.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following points: • amyloplast drawn and labelled (1) • chloroplast drawn and labelled (1) • tonoplast drawn and labelled (1)	<u>Example of diagram</u>  {amyloplast/chloroplast} < nucleus < tonoplast ignore internal details of structure do not accept the wrong location for the structures do not accept double membrane on tonoplast tonoplast label should touch membrane	(3)

Question Number	Answer	Additional guidance	Mark
(b)	• modifies and packages {proteins/enzymes} / processes and packages lipids	ACCEPT modifies {proteins/enzymes/lipids} / packages {proteins/enzymes/lipids} do not accept synthesises proteins do not accept ref to proteins being packaged for transport to GA	(1)

Question Number	Answer				Mark
(c)					
	Structure	Archaea only	Bacteria only	Eukarya only	More than one domain
	Cell membrane	☐	☐	☐	☒
	nucleolus	☐	☐	☒	☐
	cell wall	☐	☐	☐	☒
	70S (small) ribosome	☐	☐	☐	☒
					(4)

Q4.

Question Number	Answer	Additional guidance	Mark
(a)	A calculation showing the following steps: • mass of bran calculated (1) • mass of fibre calculated (1) • correct answer to two significant figures (1)	<u>Example of calculation</u> $(48 \div 100) \times 14 = 6.72$ (mg) $(6.72 \div 100) \times 43 = 2.889$ (mg) 2.9 mg Correct answer with no working scores full marks	(3)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • more sustainable (than oil-based plastic) (1) • biodegradable / can be broken down by decomposers (1) • carbon neutral (1)	ACCEPT ORA for oil-based plastic ACCEPT renewable / can be regrown / available for future generations ALLOW can decompose ACCEPT {does not contribute to /reduces} {greenhouse effect / global warming}	(3)

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes three of the following points: • pollen tube transports {generative nucleus/male nuclei} to {embryo sac / ovary / micropyle} (1) • (by releasing) digestive enzymes (1) • one of the male nuclei {fertilises / fuses with} the (two) polar nuclei (1) • (causing) the formation of a {<u>3n/ triploid</u>} endosperm (nucleus) (1)	ACCEPT pollen tube transports {generative nucleus/male nuclei} down the style ACCEPT male gamete / sperm nucleus ACCEPT male gamete / {sperm / haploid} nucleus	(3)

Q5.

Question Number	Answer	Additional guidance	Mark
(a)	(adding a stain) allows structures to be seen / {differentiate / increase contrast} between structures	e.g. chromosomes, DNA, lignin, organelles etc ACCEPT show detail more clearly ACCEPT converse argument for specimens which are not stained ignore to make specimens more visible	(1)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes four of the following points: - cellulose molecules can be organised into microfibrils. (1) (due to layers of) {cellulose / microfibrils} arranged in {different directions / a mesh} (1) {hydrogen bonds in cellulose molecules / hydrogen bonds in microfibrils / layers (of microfibrils) / lignin / secondary thickening / pectate} add {strength / support / stability} (1) {{(cellulose) microfibrils / mesh} held together by {pectin / pectate} (1) - lignin makes {outside of xylem vessels / cell wall} impermeable (to water) (1) - the structure of lignin described (1)	ACCEPT lignin arrangement contributes to {rigidity / flexibility} (of vessel) ACCEPT cellulose microfibrils can't slide over each other ACCEPT lignin makes {cell walls / xylem} waterproof e.g. rings, spirals, ladders	(4)

Q6.

Question Number	Answer	Additional guidance	Mark
(a)(i)	an alternative form of a gene	accept version of a gene	(1)

Question Number	Answer	Mark
(a)(ii)	The only correct answer is A ccddee B is not correct because all alleles need to be recessive C is not correct because all alleles need to be recessive D is not correct because all alleles need to be recessive	(1)

Question Number	Answer	Additional guidance	Mark
(a)(iii)	A description that includes the following points: - polypeptide chain enters the rER (1) {secondary/ tertiary} structure formed (1) - polypeptide is packaged into vesicles (by rER) / {(rER) vesicles fuse with / protein enters} Golgi (1) - carbohydrate added (to protein in Golgi) (1) (glyco)protein is packaged into vesicles (by Golgi) and transported to cell surface membrane (1)	accept 3D structure formed / bonds form between different R groups accept transported in vesicle to the Golgi accept glycosylation occurs (in the Golgi) ignore modification occurs in Golgi without reference to carbohydrate being added accept (glyco)protein is packaged into vesicles (by Golgi) and vesicle fuses with cell surface membrane	(5)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: - the greater the number of recessive alleles the lighter the colour of the seed / the greater the number of dominant alleles the deeper the red colour (1) - random assortment and crossing over results in (gamete) variation (1) - random fertilisation (of gametes) results in (seed) variation (1) - low probability of {inheriting 0/6 recessive alleles / egg cell with no recessive alleles being randomly fertilised by sperm cell with no recessive alleles} (1)	accept converse accept correct statement using information from table e.g. linking a colour to number of recessive alleles / linking colour to frequency / normal distribution accept the gametes vary in the number of {recessive/dominant} alleles they contain accept converse for chance of inheriting {3 recessive / 3 dominant} alleles	(3)

Q7.

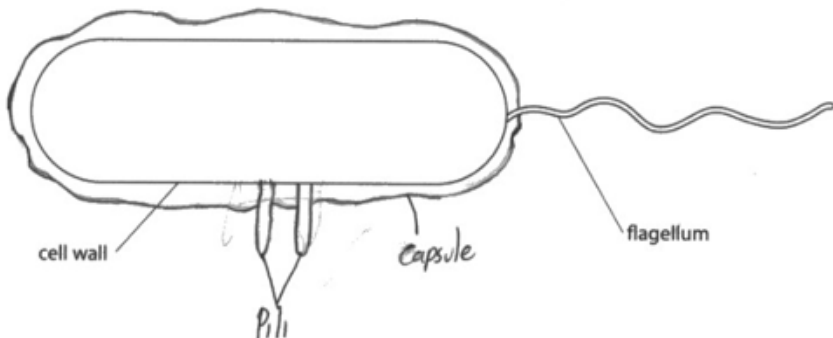
Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes two of the following points: - many genes / genes at different loci (1) {contribute to / code for} the same {characteristic / trait} (1)	ignore alleles unless correctly qualified Accept different positions on a chromosome	(2)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is B <i>A is not correct because it does not show a normal distribution</i> <i>C is not correct because it does not show a normal distribution</i> <i>D is not correct because it does not show a normal distribution</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	1.61(m)		(1)

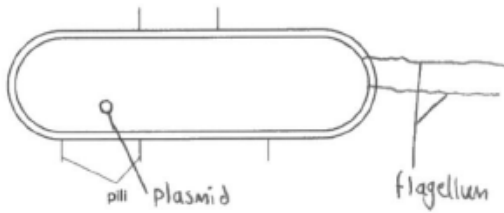
Question Number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes three of the following points: • {height / phenotype / a characteristic} is also affected by the environment (1) • {malnutrition / lack of nutrients} (1) • example of another environmental factor (which would reduce energy available for growth) (1) • height depends on the combination of alleles inherited (1)	Accept named nutrient Accept (could be taller) due to more nutrients than her parents e.g. disease, lives in very cold climate and more energy used for heat production, idea of excessive exercise, death of child, mutation Accept reverse argument (for child being taller)	(3)

Q8.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that includes the following points: - capsule correctly drawn and labelled (1) (at least) two pili correctly drawn and labelled (1)	<u>Example of diagram</u> 	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to four of the following points: - increasing sodium chloride concentrations (above 10 g dm^{-3}) decreases the growth rate (of both bacteria) (1) (salt concentration between $0-6 \text{ g dm}^{-3}$ caused) an initial {increase / constant} rate (1) - more rapid decrease in <i>L. piscium</i> growth rate (1) <i>B. thermosphacta</i> had a larger growth rate (than <i>L. piscium</i> at all sodium chloride concentrations) (1) <i>B. thermosphacta</i> was able to continue growing in sodium chloride concentrations above {22-25} g dm^{-3} whereas <i>L. piscium</i> had no growth / <i>L. piscium</i> stopped growing at a concentration {38-46} g dm^{-3} below the concentration that <i>B. thermosphacta</i> stopped growing (1) - data is more scattered about the line of best fit for <i>B. thermosphacta</i> (than <i>L. piscium</i>)	ACCEPT negative correlation (between sodium chloride concentration and growth rate) ACCEPT converse ACCEPT converse Accept <i>B. thermosphacta</i> is more {tolerant / resistant} (than <i>L. piscium</i>) of higher sodium chloride concentrations Accept <i>B. thermosphacta</i> stopped growing at {62-70} g dm^{-3} whereas <i>L. piscium</i> stopped growing at {22-24} g dm^{-3} ACCEPT converse	(4)

Question Number	Answer	Mark
(a)	The only correct answer is C two A is not correct because eukarya does not contain prokaryotic organisms B is not correct because both archaea and bacteria contain prokaryotic organisms D is not correct because both archaea and bacteria contain prokaryotic organisms	(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that makes reference to the following point: - flagellum drawn with origin on cell membrane and labelled (1) - plasmid drawn and labelled (1)	<u>Example of diagram</u> 	(2)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	contains {genes / DNA / (genetic) information} to make proteins	Accept to enable horizontal transfer of (genetic) information / used to exchange (genetic) information with other (prokaryotic) cells Accept contains {DNA / (genetic) information} for antibiotic resistance	(1)

Question Number	Answer	Additional guidance	Mark
(c)(i)	An answer that makes reference to the following point: prokaryotic ribosomes are {70S / small} whereas eukaryotic are {80S / large}	Accept {fewer / only three} strands of rRNA in prokaryote (four in eukaryote) Accept all prokaryotic ribosomes are free floating whereas some eukaryotic ribosomes are attached to membranes	(1)

Question Number	Answer	Mark
(c)(ii)	The only correct answer is B one A is not correct because ribosomes are located inside chloroplasts and mitochondria C is not correct because ribosomes are located on rER and are involved in translation D is not correct because ribosomes are located on rER and are involved in translation	(1)

Q10.

Question Number	Answer
* (a)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. • description of table data e.g., the more dominant alleles present in the zygote increases the darkness of the skin, • description of polygenic inheritance • recognition that {3 genes / 6 alleles} involved with this phenotype / each gamete contains 3 alleles involved with this phenotype • description of graph data • e.g., phenotype shows normal distribution / phenotype shows continuous variation • e.g., offspring have highest probability of inheriting {3 dominant alleles/medium skin colour} • consideration that large variation due to crossing over of {genetic material / allele / DNA} in prophase I • description of crossing over • consideration that large variation due to random assortment of chromosomes in metaphase I • description of random assortment • consideration that random fertilisation of genetically different gametes increases variation • consideration of probability of different types of mutation e.g., silent • consideration of {environmental variation / mutation} increasing variation e.g. sun tan, DNA methylation • explanation of how {environmental variation / mutation} would increase variation e.g. pigment production (6)

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Limited number of the most important or relevant scientific factors from the data/information provided are synthesised. No judgement is made.	1-2 sections
Level 2	3-4	Some of the most important or relevant scientific factors from the data/information provided are synthesised. A limited accurate judgement is made.	3-4 sections
Level 3	5-6	Most of the important or relevant scientific factors from the data/information provided are synthesised. A detailed and accurate judgement is made.	5-6 sections

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to two of the following points: • {increased/ more} exposure to {UV/sun} light (would result in a darker skin tone) (1) • mutation could result in {production of a protein which would result in a darker skin tone / fewer melanocytes} (1) • limited food source containing materials for pigment synthesis / disease killing pigment cells (1)	ignore different exposure to sunlight ignore may be using fake tan (unless qualified with a drug form) ACCEPT mutation may have occurred ACCEPT epigenetic modification ACCEPT skin cancer / disease	(2)

Q11.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is C - R <i>A is not correct because ribosomes are not produced in cytoplasm</i> <i>B is not correct because ribosomes are not produced in endoplasmic reticulum</i> <i>D is not correct because ribosomes are not produced in the nuclear membrane</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes two of the following points: • viewed from a different angle / one was transverse and one is longitudinal (1) • when the cell was {sliced / cut} (1) • different sizes due to different stages of {growth / development} (1)	Accept when the mitochondria / structure {T / U} was {sliced / cut}	(2)

Question Number	Answer	Additional guidance	Mark
(a)(iii)	A calculation showing the following steps: • conversion of units (1) • calculation of magnification (1)	Example of calculation: $52 \times 1000 = 52\,000$ $(52\,000 \div 3.0) = (\times)$ $17300 / 17333 / 17333.3$ Correct answer with no working shown scores full marks Incorrect unit loses one mark	(2)

Question Number	Answer	Additional guidance	Mark
(b)	A description that includes the following points: • rER packages insulin (protein) in vesicle (1) • vesicle fuses to become part of Golgi apparatus and insulin (protein) {enters Golgi apparatus / is modified} (1) • Golgi packages insulin (protein) in (secretory) vesicle / vesicle containing insulin (protein) pinched off Golgi (1) • (secretory) vesicles fuse with the cell (surface) membrane (1) • the insulin (protein) exits (beta cell) via exocytosis (1)		(5)

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: - cell specialisation (1) - because gene (for insulin production) switched off in (other pancreas cells) due to {epigenetic modification / DNA methylation / histone modification} (1) - because gene (for insulin production) {active / switched on / expressed} in these (beta) cells (1) - therefore transcription of (active insulin) gene / (active) mRNA produced (1) - translation of (active) mRNA leads to synthesis of insulin protein (1)	Accept differential gene expression in these cells Accept transcription of insulin gene only occurs in beta cells Accept reverse argument for other pancreas cells Accept reverse argument for other pancreas cells	(5)

Q12.

Question Number	Answer	Additional guidance	Mark
(a)(i)	- calculation of surface area and volume (1) - correct ratio (1)	Example of calculation: surface area = $6 \times 2.5^2 = 37.5$ volume = $2.5^3 = 15.625$ 2.4:1 ECF applies Correct answer with no workings shown scores full marks	(2)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: place where {organisms / species} live (1)		(1)

Question Number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes the following point: organisms that can reproduce with others to form fertile offspring (1)		(1)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes one of the following points: (inheritance of) {many/multiple/several/different} genes {contribute to / code for} height (of wombat) (1) - genes at different loci {contribute to / code for} height (of wombat) (1)	Accept different positions on a chromosome	(1)

Question Number	Answer	Additional guidance	Mark
(c)	A description that includes two of the following points: {long/sharp} claws / large paws (for digging) (1) {short / powerful} legs (for digging) (1) - ears face backwards / small eyes (so don't fill with soil) (1)	ACCEPT big feet / long nails ACCEPT short ears / large pupils	(2)

Q13.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is D $1.6 \times 10^3 \mu\text{m}$ <i>B is incorrect because the diameter is $1.6 \times 10^3 \mu\text{m}$</i> <i>C is incorrect because the diameter is $1.6 \times 10^3 \mu\text{m}$</i> <i>D is incorrect because the diameter is $1.6 \times 10^3 \mu\text{m}$</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(II)	A calculation showing the following steps: • correct volume from frog egg cell (1) • correct calculation (1) • correct calculated answer to 2 significant figures (1)	Mark the answer on answer line first <u>Example of calculation</u> v of frog ($= \frac{4}{3} \pi 800^3$) = 2.14×10^9 $(2.14 \times 10^9) \div 1.8 \times 10^6 = 1189$ Allow ECF = 1200 times larger Correct answer (1200 or 1.2×10^3) to 2 sig figs with no working gains full marks	(3)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that makes reference to four of the following: • egg cell contains {23 chromosomes/ half the genetic material of the skin cell} / egg cell is haploid (whereas skin cell is diploid) (1) • (therefore) fertilisation can occur to form a {diploid cell / zygote} (1) • (the egg cell genetic material is different from the skin cell) due to meiosis (1) • (the egg cell genetic material is different from the skin cell) due to crossing over (1) • (the egg cell genetic material is different from the skin cell) due to {random / independent} assortment (of homologous chromosomes) (1)	Accept {full set / original number} of chromosomes formed after fertilisation Accept fusion of nuclei Accept egg cell is formed by meiosis	(4)

Q14.

Question number	Answer	Mark
(a)	C they can produce some types of cell	(1)

Question number	Answer	Mark
(b)	A description that includes the following points: • ribosomes involved in translation resulting in two different polypeptides (1) • endoplasmic reticulum involved in folding each polypeptide into tertiary structure (1) • endoplasmic reticulum involved in transporting each polypeptide (1)	(3)

Question number	Answer	Mark
(c)(i)	A description that includes the following points: • α polypeptide increases to maximum by 6 months before birth and then stays constant (1) • β polypeptide rises slowly during pregnancy but then increases rapidly after birth (1) • γ polypeptide increases to maximum by 6 months before birth and then drops rapidly after birth (1)	(3)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes the following points: • gene for α polypeptide remains switched on as this polypeptide is present both before and after birth (1) • gene for γ polypeptide is switched off at birth so levels fall (1) • gene for β polypeptide switched on during pregnancy so levels rise (1) • credit given for an epigenetic mechanism that switches {on / off} gene expression (1)	For example, {DNA / histone} methylation switches off {genes / gene for γ polypeptide} or transcription factors switch on {genes / gene for β polypeptide}	(4)

Q15.

Question Number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following points: • packaged into a (secretory) vesicle by the Golgi {apparatus / body} (1) • (vesicle) fuses with cell surface membrane to release them outside of the cell (1)	ACCEPT transported from the Golgi {apparatus / body} in (secretory) vesicles ACCEPT exocytosis ACCEPT exocytosis in wrong context e.g. acrosomes	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to the following points: - individual sperm have slower speeds than bundled sperm (in all resistances) (1) - increase in resistance (above 0.5) decreased the speed of individual sperm more than bundled sperm / individual sperm speed decreases with increased resistance whereas bundled sperm speed {increases / stays relatively constant} (1) (because) {bundles of sperm / more flagella} can generate more force (1) {lower confidence / no significant difference} in results for 0.5 resistance due to overlap of {SD / error / range} bars / resistance has little effect on the speed of the sperm bundle as the error bars for each of the resistance overlap (1)	ACCEPT converse ACCEPT {largest / quoted comparative} difference in speed at 4.0 resistance / bundled sperm have double the speed at 4.0 resistance ACCEPT converse ACCEPT converse for other viscosities	(4)

Question Number	Answer	Additional guidance	Mark												
(c)(i)	correctly plotted bar with shading (1)	Percentage polyspermy (%) <table border="1"> <caption>Data from Bar Chart: Percentage polyspermy (%)</caption> <thead> <tr> <th>Zona Pellucida Status</th> <th>White Bar (%)</th> <th>Grey Bar (%)</th> <th>Black Bar (%)</th> </tr> </thead> <tbody> <tr> <td>Intact</td> <td>~2</td> <td>~17</td> <td>~18</td> </tr> <tr> <td>Damaged</td> <td>~2</td> <td>~33</td> <td>~52</td> </tr> </tbody> </table>	Zona Pellucida Status	White Bar (%)	Grey Bar (%)	Black Bar (%)	Intact	~2	~17	~18	Damaged	~2	~33	~52	(1)
Zona Pellucida Status	White Bar (%)	Grey Bar (%)	Black Bar (%)												
Intact	~2	~17	~18												
Damaged	~2	~33	~52												

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that makes reference to four of the following points: • there was more polyspermy of egg cells when the zona pellucida was damaged / converse for intact zona pellucida (1) • due to cortical reactions only occurring over some part of the egg cell (1) • (therefore some) areas of the egg cell not being covered by a hardened zona pellucida (1) • there was more polyspermy of egg cells with a higher sperm concentration • increased sperm cell concentration increased the likelihood of sperm cells entering {egg cell before cortical reaction occurred / through gap in hardened zona pellucida} (1)	ACCEPT {fewer/no} cortical reactions (with damaged zona pellucida) / converse for intact zona pellucida ACCEPT (therefore damaged) zona pellucida does not {harden / thicken} / converse for intact zona pellucida ACCEPT increased sperm cell concentration increased the {concentration of digestive enzymes / rate of digestion of zona pellucida} ignore increased {concentration / damaged to zona pellucida} increases number of sperm reaching the egg cell	(4)

Q16.

Question Number	Answer	Additional guidance	Mark
(a)	An explanation that includes the following points: • they are all (genetically identical due to being) derived from the zygote (cell) (1) • {DNA/ chromosomes} are replicated (in interphase / in semi-conservative replication) (1) • (therefore) each cell receives one identical copy of each {strand of DNA / chromosome} (1)	Accept the cells have divided by mitosis / mitosis results in daughter cells that are genetically identical ignore genetic material	(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	blastocyst		(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: • pluripotent stem cells have the ability to differentiate into {most cells types / heart (muscle) cells} (1) • replace the dead heart (muscle) cells / so the heart will have improved function (1)	Accept repair damage caused (to the heart muscle) by the heart attack ignore repair heart muscle cells ignore references to regeneration	(2)

Q17.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is B one <i>A is not correct because the first statement is correct</i> <i>C is not correct because the generative nucleus divides to form two haploid male gametes</i> <i>D is not correct because the generative nucleus divides to form two haploid male gametes</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	• surface area calculated (1) • difference in standard form with units (1)	4.128 (μm^2) 9.02 x 10⁻¹ μm^2	(2)

Question Number	Answer	Additional guidance	Mark
(b)	A description that makes reference to the following points: • differential gene expression (1) • by {epigenetic modification / histone modification / DNA methylation} (1) • {proteins / enzymes} synthesised (from active genes) which (permanently) modify the cell (1) • description of modification to become a sclerenchyma cell	ACCEPT only some genes are {active / switched on} / some genes are switched off ACCEPT {proteins / enzymes} {made / synthesised} produce a {structural / functional / metabolic} change e.g. synthesis of {cellulose/ microfibrils / lignin} / secondary thickening / lignification of cell walls	(4)

Question Number	Answer	Additional guidance	Mark
(c)	An answer that makes reference to four of the following points: • meiosis increases genetic variation / crossing over and {random / independent} assortment occur in meiosis (1) • the {genes / alleles / loci} for colour and grain length are linked (1) • (therefore alleles for these traits) will be inherited together / (therefore alleles for these traits) unlikely to be separated during crossing over (1) • the {genes / alleles / loci} for pea pod wrinkles and {colour/grain length} are not linked (1) • (therefore) the alleles for these traits will be inherited independently due to independent assortment (1)	ACCEPT meiosis results in haploid cells ACCEPT linkage is when {genes / alleles} are close together on the same chromosome ACCEPT allele for this trait may be separated from {colour/grain length/ other alleles} due to independent assortment	(4)

Question Number	Answer	Additional guidance	Mark
(a)(i)	to make the {chromosomes / chromatids} visible (1)	Accept DNA ignore organelles / cells	(1)

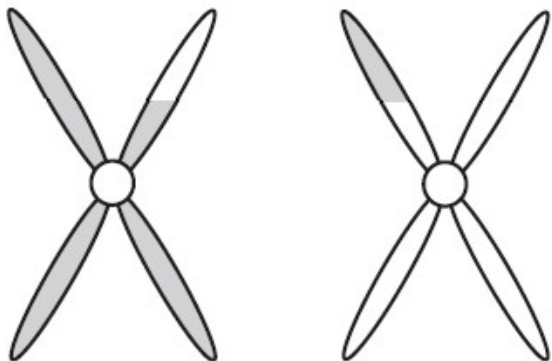
Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C R <i>A is not correct because the cell is in telophase</i> <i>B is not correct because the cell is in prophase</i> <i>D is not correct because the cell is in anaphase</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(iii)	- addition (1) - correct calculation (1)	Example of calculation: 33 and 150 $(33 \div 150) \times 100 = 22\%$ or $(33 \div 150) = 0.22$ Correct answer with no working shown scores full marks	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: (tendrils coiling) {secures / gives support to} the pea shoot / prevents the pea shoot falling over (1) - allows the pea plant to {grow taller / climb higher} (than other plants) (1) (therefore) the pea plant will {outcompete other plants / absorb more light (energy) / carry out more photosynthesis} (1)	Accept allows the plant to climb up other {plants / structures} Accept allows the pea plant to divert fewer resources into {strengthening stem / producing (named) supporting tissue (in stem)} ignore increase surface area	(3)

Question Number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: - independent assortment (of chromatids) (1) - will result in {mixture of (maternal and paternal) chromatids / different combination of alleles} in the gametes (1) - which gametes are involved (in fertilisation) are random (1)	Accept random assortment Accept chromosomes	(3)

Q19.

Question Number	Answer	Additional guidance	Mark
(a)	An answer in which: - crossing over section shaded correctly (1) - non crossing over sections shaded correctly (1)		(2)

Question Number	Answer	Mark
(b)(i)	The only correct answer is B Q <i>A is incorrect because that cell is in metaphase</i> <i>C is incorrect because that cell is in anaphase</i> <i>D is incorrect because that cell is in telophase</i>	(1)

Question Number	Answer	Additional guidance	Mark
(b)(ii)	0.5 / half / $\frac{1}{2}$ (hour)	ALLOW answer 30 minutes if clear	(1)

Question Number	Answer	Additional guidance	Mark
(b)(iii)	256		(1)

Question Number	Answer	Mark
(c)(i)	The only correct answer is A anaphase <i>B is incorrect because spindle fibres do not shorten in metaphase</i> <i>C is incorrect because spindle fibres do not shorten in prophase</i> <i>D is incorrect because spindle fibres do not shorten in telophase</i>	(1)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An answer that makes reference to the following: - Vincristine is the most effective and SRT1720 is the least effective (when given on their own) (1) - Resveratrol reduces the effectiveness of Vincristine / Vincristine increases the effectiveness of Resveratrol (1) - SRT1720 increases the effectiveness of Vincristine / Vincristine and SRT1720 is the most effective treatment (tested) (1) - comment on variability of data (1)	Accept description of correct order (V>R>SRT) Ignore drug combinations Accept Resveratrol and Vincristine more effective than Resveratrol by itself / Resveratrol and Vincristine less effective than Vincristine by itself e.g. {range / SD / error} bars do not overlap / size of error bars	(4)

Q20.

Question Number	Answer	Additional guidance	Mark
(a)(i)	Tabebuia		(1)

Question Number	Answer	Mark
(a)(ii)	The only correct answer is A amyloplast <i>B is incorrect because middle lamella is not a structure that stores starch</i> <i>C is incorrect because plasmodesmata is not a structure that stores starch</i> <i>D is incorrect because tonoplast is not a structure that stores starch</i>	(1)

Question Number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: • slime capsule prevents dehydration of cell (1) • pili allow bacteria to adhere (to surfaces) (1)	Accept protection of cell from a correct factor e.g. {white blood cells / phagocytes / antibodies / antibiotics / from harsh conditions} Accept conjugation / exchange of genetic information / exchange plasmids / attachment Ignore sexual reproduction	(2)

Question Number	Answer
(b)(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. • compound needs to be extracted from trees and used to make a drug • compounds tested on <i>Y. pestis in vitro</i> • tested on {animals / human cells} • (phase 1 / preliminary) (small scale) tests on healthy {people / volunteers} • review by independent {scientists / medics} to see if work can progress to stage 2 • (phase 2) - drug tested on {small / 100 to 500} groups of {patients / people} who have the {plague / disease} • appropriate concentrations identified • (phase 3) - drug tested on {larger groups of / 1000 to 3000} {patients / people} who have the plague • placed randomly in two groups - one group receives {treatment / drug containing the chemical compounds} and the other receives placebo • double blind test • analyse results with (appropriate) statistical test / test for significant difference (6)

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledge related to the given context with generalised comments made. The description will contain basic information with some attempt made to link knowledge and understanding to the given context.	outline of drug test given but no reference to either the plague or <i>Y. pestis</i> or bacteria core prac only = 1 mark other human drug trial = 2 marks
Level 2	3-4	Demonstrates adequate knowledge by selecting and applying some relevant biological facts/concepts to provide the description being presented. The description shows some linkages and lines of scientific reasoning with some structure.	Testing on {animal / human cells} plus at least two other phases correctly described In context of people having the disease / plague or <i>Y. pestis</i> or bacteria gives lower mark plus reference to double blind test or placebos gives higher mark
Level 3	5-6	Demonstrates comprehensive knowledge by selecting and applying relevant knowledge of biological facts/concepts to provide the description being presented. The description is clear, coherent and logically structured.	Testing on {animal / human cells} plus three phases correctly described including double blind test and placebos In context of people having the disease / plague or <i>Y. pestis</i> or bacteria gives lower mark plus correct ref to use of stats / analysis of significant difference to placebo gives higher mark
			or in vitro testing of drug on <i>Y. pestis</i> or bacteria gives higher mark

Q21.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B heterozygosity index <i>A is incorrect because the Hardy-Weinberg equation is not used to calculate genetic diversity</i> <i>C is incorrect because index of diversity is not used to calculate genetic diversity</i> <i>D is incorrect because mitotic index is not used to calculate genetic diversity</i>	(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that makes reference to the following: genetic diversity considers one species whereas species richness considers {different / number of} species (1)	Mark as a whole Accept genetic diversity considers one population whereas species richness considers {one habitat / several populations}	(2)
	genetic diversity considers {alleles / genotypes} whereas species richness {is within a habitat / considers whole organisms / counts number of species (in an area)} (1)	Accept gene pool Ignore genes Accept specific area / ecosystem	

Question Number	Answer	Additional guidance	Mark
(b)	An answer that makes reference to two of the following: - can store more seeds as they {take up less space / are smaller} (1) - seeds need less {maintenance / cost} (1) - seeds can {survive longer than plants / be frozen} (1)	Accept growing plants takes up more space Accept more seeds stored aids maintenance of genetic diversity Accept converse for plants Accept seeds can be stored for longer	(2)

Question Number	Answer	Additional guidance	Mark
(c)(i)	A calculation showing the following steps: - correct difference (1) - correct percentage increase (1)	Mark the answer on answer line first <u>Example of calculation:</u> $8.2 - 3.3 / 8.2 \times 10^5 - 3.3 \times 10^5 / 4.9 / 4.9 \times 10^5 / 490000$ $(4.9 \div 3.3) \times 100 = 148 / 148.48 / 148.5$ Correct answer (148 / 148.48 / 148.5) with no working shown gains full marks Accept for one mark only 59.8 / 59.756 / 59.76 / 60	(2)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that makes reference to four of the following: • (all Cavendish plants) are susceptible to the fungus because they are {genetically identical / clones} (1) • whereas different varieties may have resistance to the fungus / contain an allele for resistance (to fungus) (1) • (therefore breeding could) increase genetic {diversity / variation} (1) • resulting in (new banana) plants with resistance to {fungus / Panama disease} (1)	Ignore mutations / immunity Accept do not contain an allele for resistance (to fungus) Accept contain an advantageous allele Ignore 'genes' unless qualified with alleles Accept increase gene pool Accept {offspring / new varieties} survive and reproduce	(4)

Q22.

Question Number	Answer	Additional guidance	Mark
(a)	The correct answer is C Y <i>A is incorrect because the nucleus contains the genetic information used in the synthesis of acrosomal enzymes</i> <i>B is incorrect because the nucleus contains the genetic information used in the synthesis of acrosomal enzymes</i> <i>D is incorrect because the nucleus contains the genetic information used in the synthesis of acrosomal enzymes</i>		(1)

Question Number	Answer	Additional guidance	Mark
(b)	• morula		(1)

Question Number	Answer	Additional guidance	Mark
(c)(I)	A description that makes reference to one of the following pairs: Either: - DNA methylation / adds methyl groups to DNA (1) (DNA methylation) causes the (switching off / silencing) of gene(s) (1) Or: - histone modification / (methylation / phosphorylation/ acetylation) of histone (1) (histone modification) causes the (switching off / silencing / activation) of gene(s) / (1)	Accept prevents (transcription / expression) of gene(s) Accept activates genes Accept ubiquitylation / sumoylation Accept prevents (transcription / expression) of gene(s) / allows (transcription / expression) of gene(s)	(2)

Question Number	Answer	Additional guidance	Mark
(c)(II)	An explanation that makes reference to the following: - transcription of active genes / active mRNA produced (1) - therefore (certain / specific) proteins produced / (1) - these proteins (determine / change) cell (structure / function) (1)	Accept named example Accept translation at the ribosomes produces proteins Accept description Ignore modifies the cell unqualified	(3)

Question Number	Answer
(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. Basic information - genotype is shown by the different allele combinations - the gene has (multiple / four) alleles - one copy of each allele is inherited from each (parent / gamete) - phenotype is the result of interaction between the genotype and the environment / phenotype can sometimes just be determined by genotype - fur colour is affected by (genotype / allele combinations) and the (environment / (body) temperature) - colour may be camouflage Enzyme production - the (gene / alleles) code(s) for the production of an enzyme involved in producing fur colour (active) mRNA is produced from the allele(s) leading to synthesis of (protein / enzyme) Black rabbit - black rabbit has the dominant allele (C) / is homozygous dominant / heterozygous dominant - C is the dominant allele Albino rabbit - albino has recessive alleles / is homozygous recessive Himalayan linked to enzyme (Himalayan albino / $c^h c^h$) produce the enzyme which becomes inactive at high temperatures - the enzyme must be involved in producing the dark colour of the fur Himalayan explanation - the colour is not produced at body temperatures in Himalayan albino, causing the (warmer part of the body to have white fur / cooler parts of the body to have dark fur)

(6)

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	1 aspect correctly discussed with some attempt made to link knowledge and understanding to the given context = 1 mark 2 aspects correctly discussed with some attempt made to link knowledge and understanding to the given context = 2 marks
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts / concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	3 aspects correctly discussed which some linkages and lines of scientific reasoning with some structure = 3 marks 4 aspects correctly discussed which some linkages and lines of scientific reasoning with some structure = 4 marks
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts / concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	A well-developed and sustained line of scientific reasoning for 5 of the 6 aspects which is clear and logically structured = 5 marks A well-developed and sustained line of scientific reasoning for all 6 aspects which is clear and logically structured = 6 marks

Q23.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B Golgi apparatus <i>A is incorrect because centrioles do not have several curved membrane-bound sacs of decreasing size</i> <i>C is incorrect because rough endoplasmic reticulum does not have several curved membrane-bound sacs of decreasing size</i> <i>D is incorrect because smooth endoplasmic reticulum does not have several curved membrane-bound sacs of decreasing size</i>	(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: - the {magnification / resolution} of a light microscope is not high enough (to see this organelle) (1) - because it is very small (1)	Accept higher {magnification / resolution} of electron microscope is needed to see this organelle Accept small	(2)

Question Number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes one of the following points: (analysis of/ comparison of/ similarities in / differences in) {DNA / RNA / proteins / amino acid sequences / enzymes / ribosomes / membrane components / cell wall components} (1)	ACCEPT patterns in non-coding DNA ACCEPT genes ignore organelles	(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	A description that includes three of the following points: - peer review (1) - repetition of experiments (by other scientists to see if same data are collected) (1) {analysis / evaluation / discussion / comparison} of data (1)	ACCEPT extend the analysis e.g. look for {similarities / differences} in more genes (1)	(2)

Q	Answer					Mark
(b)	one mark for each correct row					(4)
	Feature	Archaea only	Archaea and Bacteria only	Archaea and Eukarya only	Archaea and Bacteria and Eukarya	
	absence of a nuclear envelope		☒			
	presence of circular DNA				☒	
	presence of a cell membrane				☒	
	presence of ribosomes				☒	

Q25.

Question Number	Answer	Mark
(a)(i)	The only correct answer is B covered in 80S (large) ribosomes <i>A is not correct because rER is covered in 80S (large) ribosomes</i> <i>C is not correct because rER forms vesicles containing polypeptides</i> <i>D is not correct because rER forms vesicles containing polypeptides</i>	(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: (smooth endoplasmic reticulum synthesises) lipid /steroids / named steroid hormone	ACCEPT hormones IGNORE (named) peptide hormone	(1)

Question Number	Answer	Additional guidance	Mark
(a)(iii)	A description that includes the following points: - nucleolus (1) - named genetic material (1)	ACCEPT ribosomes / rRNA e.g. DNA / chromatin / chromatid / chromosomes / nucleosome / mRNA ACCEPT histones	(2)

Question Number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: - because of water uptake / increased {volume of cytoplasm / size of vacuole} (1) (increase in size due to) {synthesis/production} of {organelles / (named) proteins / enzymes} (1) - therefore {synthesis/production} of {new/more} cell {membrane / wall} (1)	ACCEPT organelles increase in size	(3)

Q26.

Question Number	Answer	Additional guidance	Mark
(a)(i)	The only correct answer is B X <i>A is not correct because W is chromosomal DNA / nucleoid</i> <i>C is not correct because Y is a pilus</i> <i>D is not correct because Z is the cell wall</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	The only correct answer is C Y <i>A is not correct because V is a ribosome</i> <i>B is not correct because X is a plasmid</i> <i>D is not correct because Z is the cell wall</i>		(1)

Question Number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes one of the following points: - ribosomes in prokaryotic cells are smaller (than those in eukaryotic cells) (1) Or - ribosomes in prokaryotic cells are 70S whereas those in eukaryotic cells are 80S (1)	Accept ribosomes in prokaryotic cells contain less RNA (than those in eukaryotic cells)	(1)

Question Number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: (capsule) prevents dehydration of cell (1) (flagellum) for (cell) motility (1)	Mark first answer Accept capsule has adhesive properties / covers antigens / protection of cell from a correct factor e.g. {bacteriophages / phagocytes / antibodies / antibiotics / (described) harsh conditions} Accept movement of cell	(2)

Q27.

Question number	Answer	Mark
(a)	A J	(1)

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because this structure is very small (1) • and only an electron microscope has the ability to magnify this much (1)	Accept converse statement	(2)

Question number	Answer	Mark
(c)	An explanation that includes the following points: • because the two membranes are very close together (1) • and the resolution of this microscope is not high enough (1)	(2)

Question number	Answer	Mark
(d)(i)	An explanation that includes the following points: • mitosis results in two cells that each have a nucleus (1) • each bud contains a full set of chromosomes (1) • so the buds are genetically identical to the parent yeast cell (1)	(3)

Question number	Answer	Mark
(d)(ii)	An answer that includes the following points: • because new cell structures need to be made in order for the bud to grow (1) • therefore oxygen is needed to produce the ATP (1) • therefore {glucose is needed to produce the ATP / amino acids are needed to make proteins} (1)	(3)